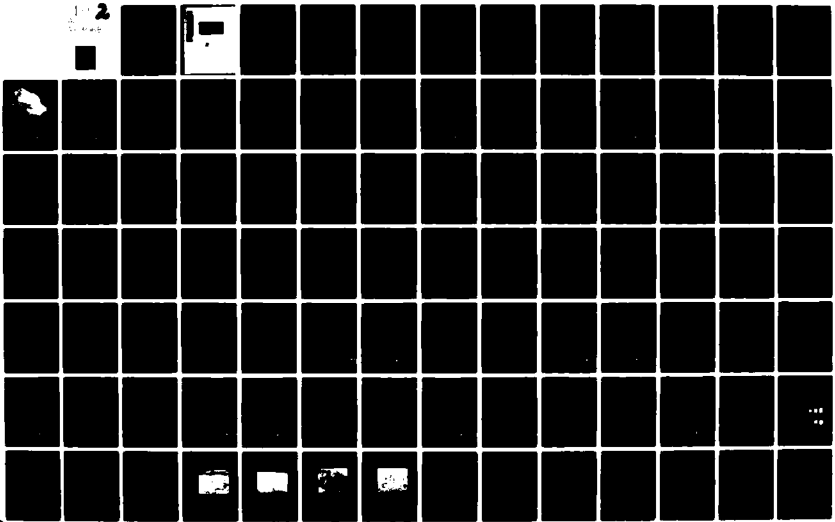
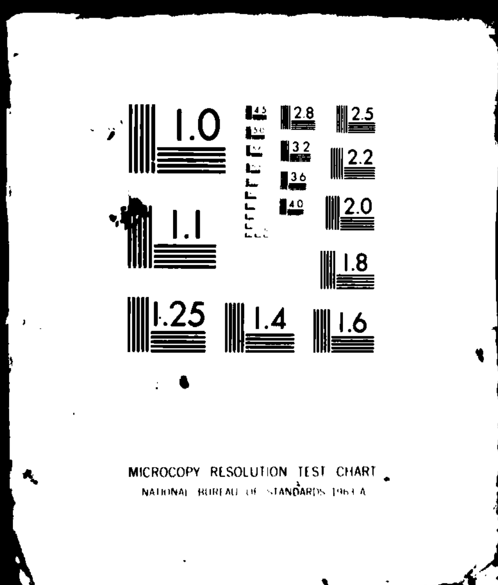
AD-A113 068 ERTEC WESTERN INC LONG BEACH CA F/G 8/7
AGGREGATE RESOURCES STUDY, CAVE AND STEPTOE VALLEYS, NEVADA.(U)
SEP 81 F04704-80-C-0006
UNCLASSIFIED E-TR-37-J NL



IFIED

1 OF 2

AD-A113068



PHOTOGRAPH THIS SHEET

AD-A113068

DTIC ACCESSION NUMBER

II

LEVEL

1

INVENTORY

E-TR-37-J

DOCUMENT IDENTIFICATION

This document has been approved for public release and sale; its distribution is unlimited.

DISTRIBUTION STATEMENT

ACCESSION FOR		
NTIS	GRA&I	☒
DTIC	TAB	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION /		
AVAILABILITY CODES		
DIST	AVAIL AND/OR SPECIAL	
A		

DISTRIBUTION STAMP

DTIC COPY INSPECTED 2

DTIC
SELECTE
APR 0 7 1982
E

DATE ACCESSIONED

"Original contains color plates: All DTIC reproductions will be in black and white"

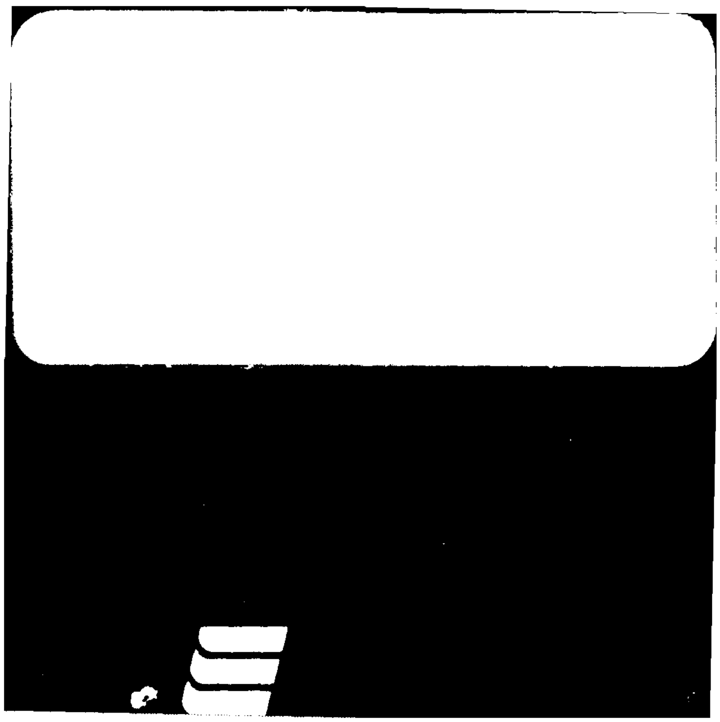
82 03 18 119

DATE RECEIVED IN DTIC

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDA-2

DTIC FORM OCT 79 70A

DOCUMENT PROCESSING SHEET



E-TR-37-j

AGGREGATE RESOURCES STUDY

CAVE AND STEPTOE VALLEYS

NEVADA

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

Ertec Western, Inc.
3777 Long Beach Boulevard
Long Beach, California 90807

25 September 1981

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: E-TR-37-j

2. GOVT ACCESSION NO.: AD-A113068

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): Aggregate Resources Study Cave + Steptoe Valleys Nevada

5. TYPE OF REPORT & PERIOD COVERED: Final

6. PERFORMING ORG. REPORT NUMBER: E-TR-37-j

7. AUTHOR(s): Ertec Western, Inc

8. CONTRACT OR GRANT NUMBER(s): F04704-80-C-0006

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Ertec Western Inc. (formerly Fugro National) P.O. Box 7765 Long Beach Ca 90807

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 64312 F

11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Department of the Air Force Space and Missile Systems Organization Norton AFB Ca 92409 (SAMSO)

12. REPORT DATE: 25 Sep 81

13. NUMBER OF PAGES: 45

14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office):

15. SECURITY CLASS. (of this report):

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Distribution Unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Geology ~~Setting~~, ~~Potential~~ Aggregate ~~Sources~~ grain size, trench logs, sieve analysis, alluvium, basin fill

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains the Valley-Specific Aggregate Resources Study (VSARS) evaluation for Cave and Steptoe valleys and surrounding areas in Nevada. It is the tenth in a series of reports that contain valley-specific aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials. The findings presented are based on field reconnaissance and limited laboratory testing, existing data from the Nevada Department of Highways, previous regional aggregate investigations, and ongoing Verification studies.

FOREWORD

This report was prepared for the Department of the Air Force, Ballistic Missile Office (BMO), in compliance with Contract No. F04704-80-C-0006, CDRL Item No. 004A2. It presents the results of Valley-Specific Aggregate Resources Studies within and adjacent to selected lands in Utah and Nevada that are under consideration for siting the MX system.

This volume contains the results of the Aggregate Resources study in Cave and Steptoe valleys. It is the tenth of several Valley Specific Aggregate Resources investigations which will be prepared as separate volumes. Results of this report are presented as text, appendices, and two drawings.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS (Cont.)

LIST OF DRAWINGS

EXECUTIVE SUMMARY

This report contains the Valley-Specific Aggregate Resources Study (VSARS) evaluation for Cave and Steptoe valleys and surrounding areas in Nevada. It is the tenth in a series of reports that contain valley-specific aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials. The findings presented are based on field reconnaissance and limited laboratory testing, existing data from the Nevada Department of Highways, previous regional aggregate investigations, and ongoing Verification studies.

A classification system based on aggregate type and potential use was developed to rank the suitability of all basin-fill and rock aggregate sources. Four aggregate types have been designated; coarse, fine, coarse and fine (multiple) aggregates derived from basin-fill sources, and crushed rock aggregates derived from rock sources. Each aggregate type was then classified using the following definitions:

Class I	Potentially suitable concrete aggregate or road-base material source;
Class II	Possibly unsuitable concrete aggregate/potentially suitable road-base material source; and
Class III	Unsuitable concrete aggregate or road-base material source.

Decisions on assigning a particular aggregate source to one of the three classes were determined from existing test data and

laboratory tests performed as part of this study (abrasion resistance, soundness, and alkali reactivity) and, to a lesser degree, field visual observations.

Emphasis in this study is on the identification of Class I basin-fill coarse aggregate. These deposits are considered to be the primary sources of concrete and road-base materials for MX construction. Results of the study are presented in a 1:125,000 scale aggregate resources map (Drawing 2) and are summarized as follows:

1. Coarse Aggregate - Extensive Class I coarse aggregate deposits are located in Cave and Steptoe valleys in:

   a. Alluvial fan deposits (Aafs, Aaf) along the east and west sides of the central and northern Steptoe Valley study area;

   b. Alluvial fan deposits (Aafs) in southwestern Cave Valley; and

   c. Older lacustrine deposits (Aols) in southern Cave Valley.

   Potentially suitable Class II coarse aggregate sources are widespread in the study area. They are typically located within alluvial fan (Aafs, Aaf, Aafg), older lacustrine (Aols), and undifferentiated alluvial (Au) deposits flanking Class I and/or Class II rock sources.

2. Fine Aggregate - Many coarse aggregate basin-fill sources are also potential multiple sources (coarse and fine) that will supply varying quantities of fine aggregate either from the natural deposit or during processing. Class I fine

aggregate (multiple-type) sources were specifically delineated in alluvial fan (Aaf, Aafs) and undifferentiated alluvial (Au) deposits in the northeastern Steptoe Valley study area.

3. Crushed Rock - Abundant Class I crushed rock sources are present throughout the study area. The most suitable units are:

   a. Undifferentiated carbonate rocks (Cau) from the Guilmette Formation;

   b. Limestone (Ls) from the Pogonip Group, the Joana and Ely limestones, and undifferentiated upper Cambrian, Pennsylvanian, and Permian rocks;

   c. Dolomite (Do) from the Laketown, Sevy, and Simonson dolomites;

   d. Quartzite (Qtz) from the Prospect Mountain, Eureka, and Scotty Wash quartzites; and

   e. Granitic rock (Gr) in southern Cave Valley.

The usability of any of these rock units as sources of crushed-rock aggregates depends on their accessibility and minability within the study area.

Additional aggregate testing and field investigations will be required to further refine the lateral and vertical extents of classification boundaries and define exact physical and chemical characteristics of a particular deposit or rock source within the study area.

1.0 INTRODUCTION

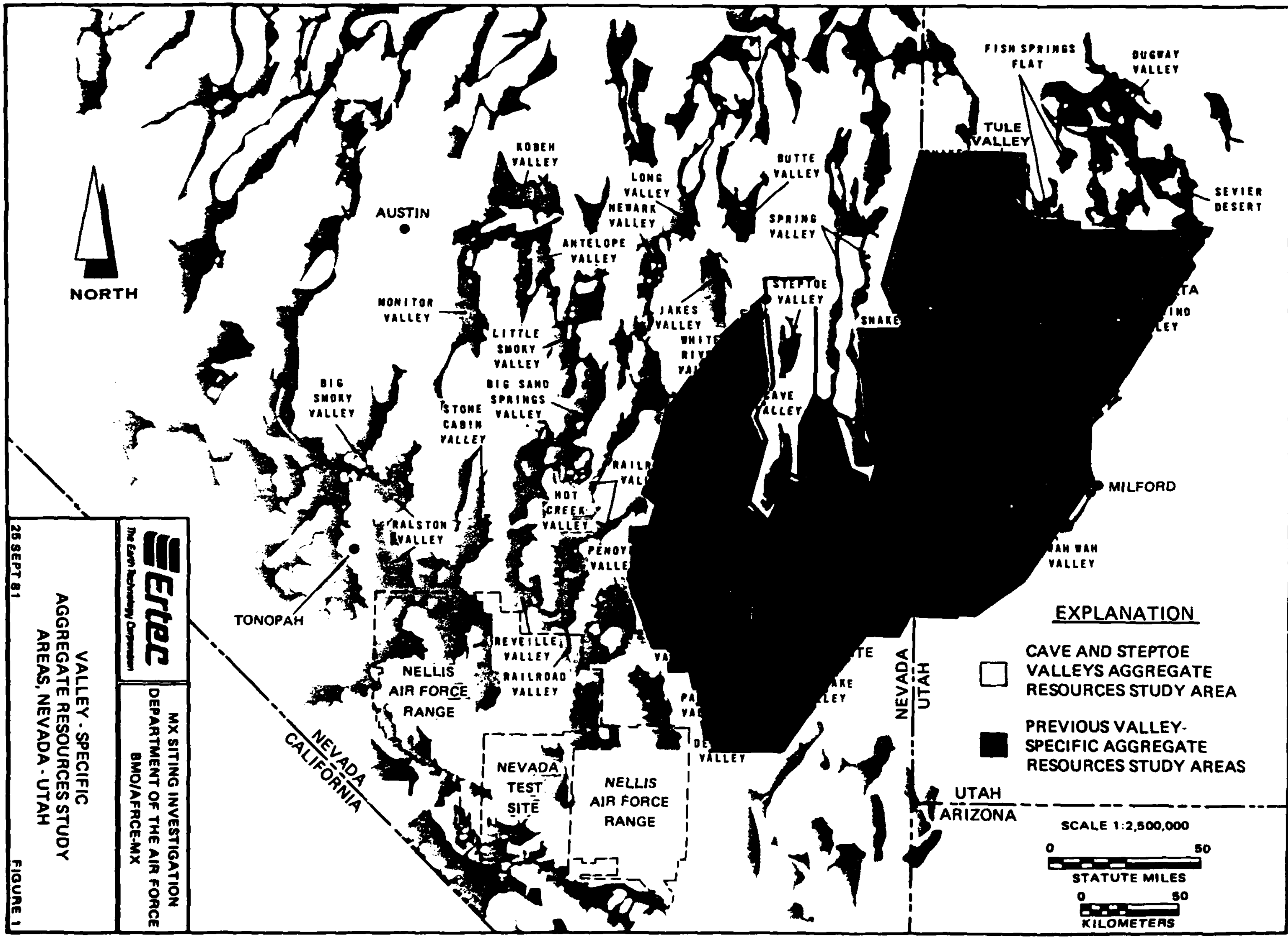
1.1 STUDY AREA

This report presents the results of the Valley-Specific Aggregate Resources Study (VSARS) completed for Cave and Steptoe valleys (Figure 1). The study area is located in portions of Lincoln and White Pine counties, Nevada. Cave and Steptoe valleys are north-south trending alluvial basins bounded by mountain ranges of sedimentary and/or igneous rocks. The Egan Range lies to the west and the Schell Creek and Duck Creek ranges to the east. Adjoining basins are Spring, Lake, Muleshoe, and White River valleys. Paved road access into Steptoe Valley is via U.S. and State Highway 6/50/93. Graded roads and four-wheel-drive trails are present throughout the study area.

The study area is comprised mainly of desert rangeland managed by the Bureau of Land Management (BLM). Portions of the northern site area are part of the Humboldt National Forest. Isolated private land and localized mining claims are also present.

1.2 BACKGROUND

The MX aggregate program began in 1977 with the investigation of Department of Defense (DoD) and BLM lands in California, Nevada, Arizona, New Mexico, and Texas (FN-TR-20D). Refinement of the MX siting area added portions of Utah and Nevada that were not studied in the initial Aggregate Resources Evaluation Investigation (AREI). This additional area (Figure 2), defined as the Utah Aggregate Resources Study Area (UARSA), was evaluated in



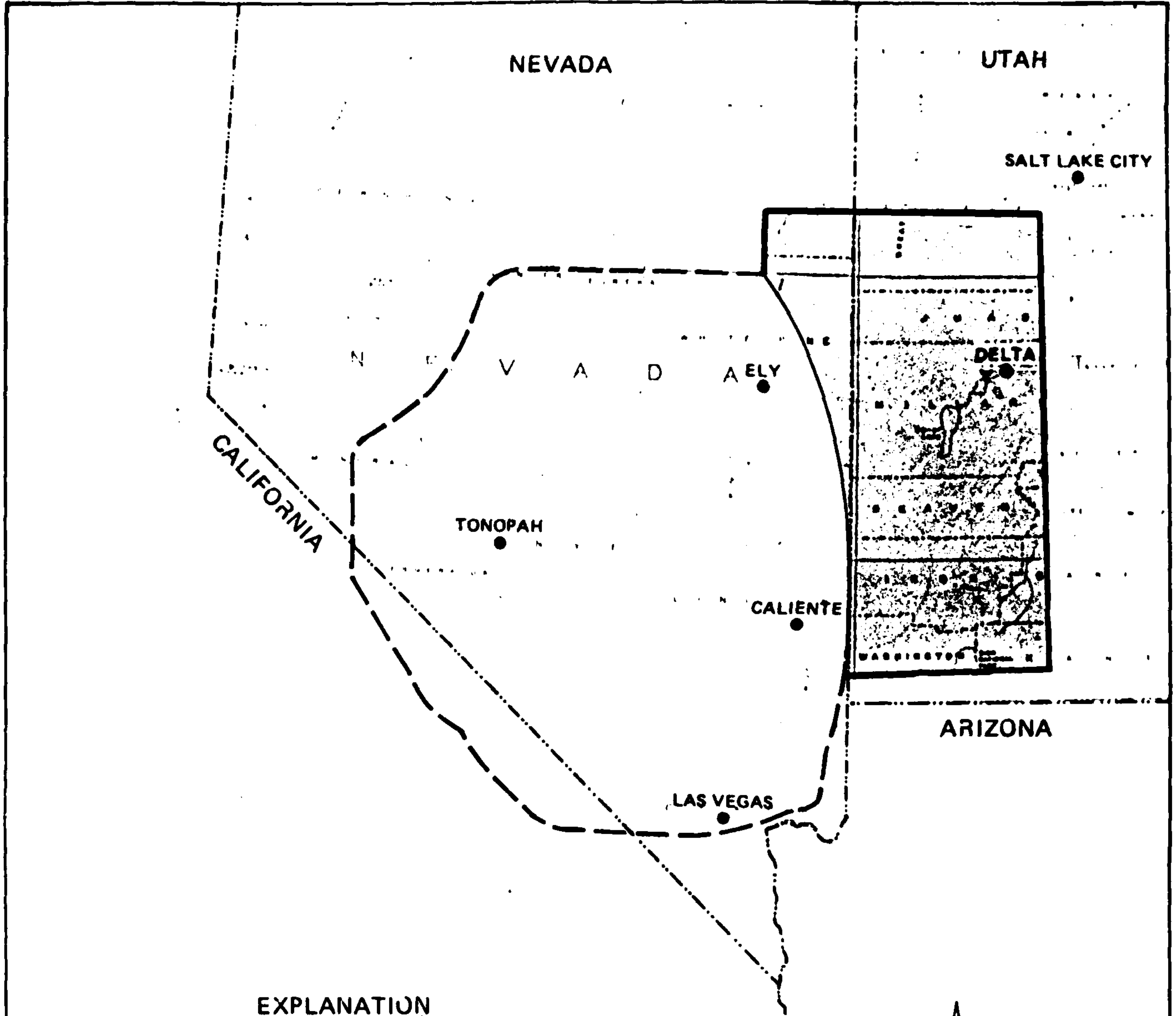
Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

VALLEY - SPECIFIC
AGGREGATE RESOURCES STUDY
AREAS, NEVADA - UTAH

25 SEPT 81

FIGURE 1



EXPLANATION

NEVADA–CALIFORNIA AGGREGATE RESOURCES STUDY AREA, FY 78 (FN-TR-20D)

UTAH AGGREGATE RESOURCES STUDY AREA, FY 79

NORTH

SCALE 1: 5,000,000

0 50 100
STATUTE MILES

0 50 100
KILOMETERS

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

UTAH–NEVADA REGIONAL
AGGREGATE STUDIES

28 SEPT 81

FIGURE 2

the fall 1979, and a second general aggregate resources report (FN-TR-34) was submitted on 3 March 1980. Both general aggregate investigations were designed to provide regional information on the location, quality, and quantity of aggregates that could be used in the construction of the MX system.

Subsequent to the general studies, VSARS were developed in FY 79 to provide more-detailed information on potential aggregate sources in specified valley areas.

1.3 OBJECTIVES

The primary objective of the VSARS program is to classify, on a valley basis, basin-fill deposits and rock units for suitability as concrete and road-base construction materials. The format is designed to select and present the locations of the most acceptable aggregate sources for preliminary construction planning and follow-on detailed aggregate investigations.

1.4 SCOPE

The scope of this investigation required office and field studies and included the following:

1. Collection and analyses of available existing data on the quality and quantity of potential concrete aggregate and road-base material sources. American Society of Testing and Materials (ASTM) standards and Standard Specifications for Public Works Construction (SSPWC) were used to evaluate quality.

2. Aerial and ground reconnaissance of all identified potential aggregate sources in the valley area, with more-detailed investigation and sample collection of likely basin-fill (coarse and fine aggregates) and rock (crushed-rock aggregates) construction material sources.

3. Laboratory testing to supplement available existing data and to provide detailed information to assist in determining the

suitability of specific basin-fill or rock as construction material sources within the study area.

4. Development and application of an aggregate classification system (Section 2.5) that emphasizes aggregate type (coarse, fine, or crushed rock) and potential construction use (concrete and/or road base).

2.0 STUDY APPROACH

2.1 EXISTING DATA

Collection of existing test data from available sources was an important factor in the VSARS program. The principal source of existing data pertaining to aggregate construction materials was the Nevada Department of Highways (Appendix A). The majority of this information is related to the use of aggregate material for asphaltic concrete, base course in road construction, or ballast material; however, many of the suitability tests for these types of construction materials are similar to those for concrete and are applicable to this investigation.

2.2 SUPPLEMENTAL ERTEC DATA

Supplemental Ertec data were obtained from 1) field data and supplementary test data collected during the general aggregate resources studies (FN-TR-20D), 2) Cave and Steptoe valleys Verification studies (E-TR-27), and 3) previous Valley Specific Aggregate Resources Studies (FN-TR-37; E-TR-37). These data were used to supplement the data obtained from this investigation presented in Appendix A.

The primary objective of the general aggregate study was a regional evaluation and ranking of all potential aggregate sources. Eight data points from the general aggregate studies were located within the Cave and Steptoe Valley VSARS area (Drawing 1). These data supplied specific aggregate information which included one 150-pound sample collected for limited laboratory testing (Appendix A).

Geologic maps produced as part of Ertec's MX Verification program were an initial source of information on the type and extent of basin-fill units within specific valley areas. While the Verification studies were not specifically designed to generate aggregate information, much of the data collected is applicable to the evaluation of aggregates in the valley. Data from five trenches, excavated during Verification studies, were used in the evaluation of grain-size gradations in the study area (Appendix A). Depths of the selected trenches ranged from 9 to 12 feet (2.7 to 3.7 m).

The VSARS program required aerial and ground reconnaissance of the study area for purposes of collecting additional information and to verify conditions determined during the data review. Included in the 50 field station data stops that were established as part of the Cave and Steptoe VSAR studies was the collection of 28 bulk samples for additional laboratory testing. Coarse- and fine-aggregate basin-fill samples were collected by sampling stream cuts or existing man-made exposures. Crushed-rock aggregate samples were obtained from exposures of fresh or slightly weathered in-place rock material whenever possible. The weight of the samples collected ranged between 100 and 150 pounds. Hand samples were collected from rock units for office analyses. In addition, field observations were made regarding the general accessibility and minability of the potential basin-fill and crushed-rock aggregate sources examined at the field station data stops.

Identification of basin-fill materials in all field studies followed ASTM D 2488-69, Description of Soils (Visual-Manual Procedure), and the Unified Soil Classification System (Appendix C). Rock identification followed procedures described in the Quarterly of the Colorado School of Mines (Travis, 1955) and Standard Investigative Nomenclature of Constituents of Natural Mineral Aggregates (ASTM C 294-69).

2.3 DATA ANALYSIS

Geologic and engineering criteria were used in the evaluation of potential aggregate sources within the study area. These were supplemented by laboratory analysis of selected samples during the valley-specific aggregate testing program (Table 1). Coarse aggregate is defined as predominantly plus 0.185 inch (4.75 mm) fine gravel to boulder basin-fill material. Fine aggregate is defined as less than 0.375 inch (9.5 mm) and predominantly less than 0.185 inch (4.75 mm), but greater than 0.0029 inch (0.074 mm), coarse to fine sand basin-fill material. The abrasion, soundness, and alkali reactivity results were considered the most critical laboratory tests for determining the use and acceptablity of a potential aggregate source.

2.4 PRESENTATION OF RESULTS

Results of the study are presented in text, tables, appendices, and two 1:125,000 scale maps. Drawing 1 presents the location of all data sites within the study area. Drawing 2 presents the location of all VSARS laboratory sample collection sites; all potential basin-fill and rock aggregate sources within the

ASTM TEST	SAMPLE TYPE AND NUMBER OF TESTS		
	COARSE	FINE	ROCK
ASTM C–88; SOUNDNESS BY USE OF MAGNESIUM SULFATE	8	17	20
ASTM C–131; RESISTANCE TO ABRASION BY USE OF THE LOS ANGELES MACHINE	17	NA	11
ASTM C–136; SIEVE ANALYSIS	17	17	NA
ASTM C–289; POTENTIAL REACTIVITY OF AGGREGATE (CHEMICAL METHOD)	7	4	4
ASTM C–127 AND C–128; SPECIFIC GRAVITY AND ABSORPTION	4	4	2

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

AGGREGATE RESOURCES STUDY
AGGREGATE TESTS
CAVE AND STEPTOE VALLEYS, NEVADA

25 SEPT 81

TABLE 1

study area; and the classification of all potential aggregate sources according to proposed aggregate use and type (Section 2.5).

Geologic unit symbols utilized in Drawing 2 relate to standard geological nomenclature whenever possible. Undifferentiated basin-fill deposits and rock units were established primarily to accommodate accuracy of data and map scale and may contain deposits which could supply significant quantities of high-quality materials. A conversion table to relate these geologic symbols to the geologic unit nomenclature used in Ertec Verification studies is contained in Appendix E.

All contacts which represent distinct boundaries between geologic units are shown as solid lines in Drawing 2. The contacts are dashed where the data were extrapolated beyond the limits of the source data or where accuracy of the data may be questionable. Local small deposits of one geologic unit may be found in close association with a larger deposit of a different geologic unit. Due to the reconnaissance level of the field investigation or map-scale limitations, these smaller deposits could not be depicted on the aggregate resources map and have been combined with the more prevalent material. Similarly, potential aggregate source classifications are preliminary and may contain lesser amounts of material of another use or type. Therefore, all classification lines are dashed and delimit the best aggregate evaluations possible at this level of investigation. In cases of highly variable rock or basin-fill units and limited

aggregate tests, boundaries could not be drawn and individual sample information is presented in Drawing 2.

Appendix A contains tables summarizing the basic data collected during Ertec's supplemental field investigations, the results of Ertec's supplemental testing programs, and existing test data gathered from various outside sources. Also included in the appendices are an explanation of caliche development (Appendix B), the Unified Soil Classification System (Appendix C), photographs of typical aggregate sources within the Cave and Steptoe valleys study area (Appendix D), and a geologic unit cross-reference table (Appendix E).

2.5 PRELIMINARY CLASSIFICATION OF POTENTIAL AGGREGATE SOURCES

A system was developed to preliminarily classify all potential aggregate sources in the study area. This classification is designed to present potential sources of coarse, fine, coarse and fine (multiple source), and crushed-rock aggregate types within a valley-specific area (Drawing 2) based on potential aggregate use (Table 2). Concrete aggregate parameters, as stated in ASTM C33-78, are the principal consideration since materials suitable for use as concrete aggregates are generally acceptable for use as road-base material. Therefore, the three classifications described below are based primarily on results of the abrasion, soundness, and alkali reactivity tests.

Class I — Potentially suitable concrete aggregate or road-base material sources. Coarse and crushed-rock aggregates which either passed abrasion, soundness, and alkali reactivity tests or passed abrasion and soundness

AGGREGATE CHARACTERISTIC[1]			AGGREGATE USE CLASSIFICATION		
			CLASS I	CLASS II	CLASS III
ABRASION RESISTANCE, PERCENT WEAR[2]			< 50	< 50	> 50
SOUNDNESS, PERCENT LOSS[3]	COARSE AGGREGATE	$Na\ SO_4$	< 12	> 12	> 12
		$Mg\ SO_4$	< 18	> 18	> 18
	FINE AGGREGATE	$Na\ SO_4$	< 10	> 10	> 10
		$Mg\ SO_4$	< 15	> 15	> 15
POTENTIAL ALKALI REACTIVITY[4]			INNOCUOUS TO POTENTIALLY DELETERIOUS	DELETERIOUS	DELETERIOUS

1. AGGREGATE CHARACTERISTIC BASED ON STANDARD TEST RESULTS
2. ASTM C131 (500 REVOLUTIONS)
3. ASTM C88 (5 CYCLES)
4. ASTM C289

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

PRELIMINARY AGGREGATE CLASSIFICATION SYSTEM VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY

25 SEPT 81

TABLE 2

tests and were not tested for alkali reactivity; fine aggregates which either passed soundness and alkali reactivity tests or passed soundness tests and were not tested for alkali reactivity.

Class II Possibly unsuitable concrete aggregate/ potentially suitable road-base material source. Coarse, fine, and crushed-rock aggregates which either failed the soundness and/or alkali reactivity tests or were classified only by field visual observations or other test data.

Class III Unsuitable concrete aggregate or road-base material sources. Coarse and crushed-rock aggregates which failed the abrasion test and were excluded from further testing. Fine and occasionally coarse aggregates composed of significant amounts of clay- and silt-sized particles.

Sources not specifically identified as Class I, II, or III from the three critical test results or clay- and silt-sized particle content are designated as Class II sources. All classifications are preliminary as additional field reconnaissance, testing, and case history studies needed to confirm adequacy, delimit areal boundaries, and define exact physical and chemical characteristics.

The following publications/sources were used in defining the three use classifications:

1. ASTM C33-78A Standard Specifications for Concrete Aggregate;
2. SSPWC Part II Construction Sections 200-1.1, 1.4, 1.5, and 1.7;
3. Literature applicable to concrete aggregates;
4. Industrial producers of concrete aggregates; and
5. Consultants in the field of concrete aggregates.

3.0 GEOLOGIC SETTING

3.1 PHYSIOGRAPHY

The study area lies entirely within the Great Basin physiographic subprovince (Fenneman, 1946). Primary physiographic features are controlled by block faulting which has produced uplifted north-south trending mountain ranges and intervening down-dropped alluvial basins.

Cave and southern Steptoe valleys are the basins within the study area. They are bounded on the west by the Egan Range and on the east by the Schell Creek and Duck Creek ranges. Elevations of the basins range from approximately 6000 feet (1829 m) in both valleys to 7000 feet (2134 m) in Cave Valley and approximately 7400 feet (2256 m) in Steptoe Valley.

Drainage in Cave Valley is internal into the Cave Valley playa. Shoreline features in Cave Valley indicate that the maximum Pleistocene lake level elevation was approximately 6140 feet (1871 m). Steptoe Valley drainage is open to the north.

3.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Geologic units representing all eras of geologic time are present within the study area. In general, the sedimentary rock units shown in Drawing 2 are Paleozoic, the volcanics are late Mesozoic and Cenozoic, while the basin-fill material is Cenozoic.

Paleozoic rocks are present throughout a large portion of the area and consist of limestone and dolomite with lesser amounts

of quartzite, sandstone, siltstone, and shale. Major exposures are located along both sides of the study area in the Egan, Schell Creek, and Duck Creek ranges.

Mesozoic and Cenozoic volcanic rocks crop out within the mapped area. They consist predominantly of ash-flow and air-fall tuffs and lava flows of dacitic to rhyolitic composition. These rocks are exposed in the Egan and Schell Creek ranges. Intrusive igneous rocks of dioritic composition are present in the southern part of the study site in the southern Schell Creek Range.

Cenozoic alluvial deposits unconformably overlie older units and consist of late Tertiary fanglomerate and Quaternary alluvial fan, older lacustrine, and stream-channel and terrace deposits. The late Tertiary fanglomerates and Quaternary older lacustrine deposits are exposed in Cave Valley. Alluvial fan deposits are extensive and widespread throughout the study area.

These geologic units have been grouped into seven rock units and four basin-fill units for use in discussing potential aggregate sources. Grouping of these units is based on similarities in physical and chemical properties and map-scale limitations. The resulting units allow for simplicity of discussion and presentation without altering the conclusions of this study. Due to differences in the geologic data base used in compiling Drawing 2 (Lincoln County geologic map in the south and White Pine County geologic map in the north), slight differences exist in

the grouped geologic units. These will be mentioned in the following text where appropriate.

3.2.1 Rock Units

Geologic rock units were grouped into the following seven categories (Drawing 2): quartzite (Qtz), limestone (Ls), dolomite (Do), carbonate rocks undifferentiated (Cau), sedimentary rocks undifferentiated (Su), granitic rocks (Gr), and volcanic rocks undifferentiated (Vu).

3.2.1.1 Quartzite - Qtz

Four quartzite units are present in the study area. They are the Precambrian McCoy Creek Group, the Cambrian Prospect Mountain Quartzite, the Ordovician Eureka Quartzite, and the Mississippian Scotty Wash Quartzite. The McCoy Creek Group is exposed only within the Egan Range in the northern part of the mapped area. The unit consists of thick-bedded, medium-grained, gray to olive quartzite with lesser amounts of dolomite and mica-schist. The Prospect Mountain crops out in the Egan Range, near the northern boundary of the study area, in the Duck Creek Range, and in the Schell Creek Range near the center of the study area. It is predominantly medium- to thick-bedded, fine- to medium-grained, pinkish-gray quartzite with locally interbedded shale. The Eureka Quartzite is located throughout the area and consists of thin- to thick-bedded, fine- to medium-grained, white to reddish-brown vitreous orthoquartzite with some interbedded sandstone and shale near the base and top of the formation. With the exception of a sampled outcrop in

in northern Cave Valley, the Eureka Quartzite was mapped with the underlying Pogonip Group (Ls) in White Pine County. The Scotty Wash Quartzite is mapped in the Egan Range only within Lincoln County. It consists of thin- to medium-bedded, reddish-brown quartzitic sandstone with local shale beds.

3.2.1.2 Limestone - Ls

Limestone is a carbonate rock that comprises much of the Paleozoic section. Mapped units in the study area consist of Cambrian Pole Canyon Limestone, undifferentiated middle and upper Cambrian rocks, Ordovician Pogonip Group (includes Eureka Quartzite in White Pine County), Mississippian Joana (mapped with Devonian and Mississippian clastic [Su] units in White Pine County), Pennsylvanian Ely, and Permian undifferentiated limestones (Pennsylvania and Permian limestone units are undifferentiated and mapped together in White Pine County). These units are exposed throughout the area and are typically hard, thin- to very thick-bedded, fine- to coarse-grained, light- to dark-gray limestone with interbedded sandstone, siltstone, shale, chert, and dolomite.

3.2.1.3 Dolomite - Do

Dolomite is a carbonate rock with high magnesium content that is found extensively within the Paleozoic section. Units mapped as dolomite include the Ordovician Ely Springs, Silurian Laketown, and Devonian Sevy and Simonson dolomites. Dolomite is exposed throughout the area and is typically medium to thick bedded, fine to coarse grained, medium to dark gray with interbedded sandstone, siltstone, shale, chert, and limestone.

3.2.1.4 Carbonate Rocks Undifferentiated - Cau

Undifferentiated carbonate rock units were mapped where complex, interbedded sequences of limestone and dolomite were present or where map scale prevented delineation of individual carbonate rock units. The Devonian Guilmette Formation is mapped as an undifferentiated carbonate rock unit within the study area. It is exposed in all mountain ranges and consists of medium- to thick-bedded, fine- to medium-grained, medium- to dark-gray limestone and dolomite with interbedded chert and sandstone.

3.2.1.5 Sedimentary Rocks Undifferentiated - Su

Undifferentiated sedimentary rocks were mapped where interbedded sandstone, siltstone, shale, limestone, and dolomite are exposed. The highly interbedded nature of these units prevents separation into individual rock types. These units are exposed throughout the study area and consist of Cambrian Pioche and Patterson Pass shales (in Lincoln County only), Mississippian Chainman Shale (in Lincoln County), undifferentiated Devonian and Mississippian rocks (in White Pine County), the upper sandstone member of the Pennsylvanian Ely Limestone, and the Permian Rib Hill Sandstone, Arcturus Formation, and Park City Group. These units are typically variegated, thin-bedded shale and siltstone or fine- to medium-grained, yellow to brown calcareous sandstone with interbedded limestone.

In addition, late Tertiary fanglomerates in northern Cave Valley are also mapped as undifferentiated sedimentary units. These

units are typically moderately well-indurated, silica-cemented, poorly bedded conglomerate and sandstone.

3.2.1.6 Granitic Rocks - Gr

Granitic rocks are exposed only in the southern Schell Creek Range near the southern boundary of the study area. This unit is a medium- to coarse-grained, brownish-gray dioritic intrusive composed predominantly of feldspar and lesser amounts of quartz and mafic minerals.

3.2.1.7 Volcanic Rocks Undifferentiated - Vu

Tertiary and locally Cretaceous undifferentiated volcanic rocks occur extensively throughout the study area. These rocks consist of a variety of interlayered volcanic ash-flow and air-fall tuffs and lava flows. Composition ranges from dacitic to rhyolitic. Individual rock units have not been delineated separately because of complex lithology and map-scale limitations.

3.2.2 Basin-fill Units

Four basin-fill units were mapped within the study area. These consist of older lacustrine (Aol), alluvial fan (Aaf), stream-channel and terrace (Aal), and undifferentiated alluvial (Au) deposits. Grain-size designations have been assigned to basin-fill units in the Verification mapped areas. Basin-fill units which have high silt and/or clay content are considered unsuitable aggregate sources (Class III) and will not be discussed. These unsuitable materials are present in active playa, and some alluvial fan and older lacustrine deposits generally located near the valley center.

3.2.2.1 Older Lacustrine Deposits - Aol

Older lacustrine deposits are mapped only in Cave Valley (locally small playa deposits may be present throughout the study area within other mapped units). The deposits ..n Cave Valley are exposed over a large area in the southern part of the valley. Older lacustrine deposits at an elevation of approximately 6140 feet (1871 m) are typically shoreline features composed of poorly graded, moderately well-stratified, loose to medium-dense sand with gravel and silt. Deposits within the valley center are generally poorly graded, moderately well-stratified, stiff, sandy silt and clay.

3.2.2.2 Alluvial Fan Deposits - Aaf

Alluvial fans are present in both Cave and Steptoe valleys and form the most extensive basin-fill deposit in the study area. They are moderately well- to poorly graded, poorly stratified sandy gravel and gravelly sand composed of subangular to angular clasts. Alluvial fans are generally coarse-grained near the mountain front and fine-grained near the basin center. Composition of surrounding source rock strongly controls the textural properties of alluvial fan deposits. Fans derived from quartzite and carbonate rocks show a greater range of gradation (boulders to clay), whereas, fans derived from volcanic and granitic sources are predominantly sand. Caliche development (Appendix B) ranges from none to Stage III, depending on fan age, composition, and gradation.

3.2.2.3 <u>Stream-Channel and Terrace Deposits - Aal</u>

Stream-channel and terrace deposits are widespread throughout the study area although most are too small to depict at the 1:125,000 map scale of Drawing 2. Mapped deposits are present along significantly large ephemeral drainages and are typically poorly graded, moderately well-stratified silt and sand with some gravel, cobbles, and boulders. Locally these units may be predominantly gravel.

3.2.2.4 <u>Alluvial Deposits Undifferentiated - Au</u>

Undifferentiated alluvial deposits consist of combinations of basin-fill units that were not delineated and/or mapped in the northern Steptoe Valley study area during Verification studies. Undifferentiated alluvial deposits in this area are unstratified to stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay derived from a variety of rock sources.

4.0 POTENTIAL AGGREGATE SOURCES

Based on the results of field visual observations and laboratory testing, basin-fill material was first subdivided into categories based on gradation (i.e., coarse, fine, and multiple sources [coarse and fine]). The material was then classified as belonging to one of the three use catagories (Section 2.5). Coarse aggregate (gravel to boulders) included material predominantly retained on the No. 4 sieve (0.185 inch [4.75 mm]). Fine aggregate (predominantly sand) includes material entirely passing the 3/8-inch sieve (0.375 inch [9.5 mm]), almost entirely passing the No. 4 sieve (0.187 inch [4.75 mm]), and retained on the No. 200 sieve (0.0029 inch [0.074 mm]). Rock units were classified only into the three use catagories.

Classification boundaries (Drawing 2) of basin-fill aggregate sources were generalized and will require additional studies to accurately define their location. Boundaries of identified crushed-rock sources are based on the areal extent of the geologic formations tested (i.e., Eureka Quartzite, Laketown Dolomite) and not on the aggregate geologic unit (i.e., Qtz, Do) described in Section 3.2.1.

4.1 BASIN-FILL SOURCES

4.1.1 Coarse Aggregate

4.1.1.1 Potentially Suitable Concrete Aggregate or Road-Base Material Sources - Class I

Class I coarse aggregate sources are located predominantly in alluvial fan deposits in Steptoe Valley and alluvial fan and older lacustrine deposits in Cave Valley.

Major Class I coarse aggregate sources are located in alluvial fan deposits (Aafs, Aaf) along the east and west sides of the central and northern Steptoe Valley study area (Drawing 2). These deposits in Steptoe Valley are typically moderately graded, poorly to moderately well-stratified, loose to medium-dense sandy gravel with some local silty gravel. Clasts are subangular to subrounded limestone with lesser amounts of dolomite and quartzite. Percentage of sand-sized material in tested samples ranges from 23 to 50 percent. Laboratory test results indicate acceptable abrasion and soundness losses and potential alkali reactivity results (where tested) were innocuous. Overburden is generally less than 3 feet (0.9 m) thick and consists of slightly cemented soils (Stage I and II caliche). Access and minability are good to very good at the tested sites. Boundaries of these source areas are tentative and will require additional studies for accurate delineation.

Alluvial fan deposits (Aafs) along the eastern flank of the Egan Range in southern Cave Valley are a Class I coarse aggregate source. These deposits are moderately graded, poorly to moderately well-stratified, medium-dense sandy gravel with 30 to 42 percent sand in tested samples. Subangular to subrounded clasts of limestone predominate. Laboratory tests show acceptable abrasion and soundness test results. Potential alkali reactivity test results were innocuous. Overburden consists of 3 to 6 feet (0.9 to 1.8 m) of soil with Stage I caliche development. Access and minability are good to very good.

Older lacustrine deposits (Aols) in southern Cave Valley are also a Class I coarse aggregate source. Tested samples indicate these deposits are poorly to moderately graded, moderately well-stratified, loose to medium-dense sandy gravel with subrounded clasts of limestone and dolomite. Acceptable abrasion and soundness test results were obtained, but potential alkali reactivity was not tested. Overburden generally consists of 3 feet (0.9 m) of soil with Stage I caliche development. Access and minability are considered good.

A stream channel and terrace deposit (Aalf) in southern Steptoe Valley was also found to be a Class I coarse aggregate source. The area sampled, a coarse-grained deposit which was localized within generally a finer-grained stream-channel deposit, was moderately to well-graded, moderately well stratified, medium-dense sandy gravel. The clasts were subrounded and the deposit consisted of 34 percent sand-sized particles. Acceptable abrasion and soundness losses were reported but potential alkali reactivity was not tested. Overburden consists of 3 feet (0.9 m) of soil with Stage I caliche development. Access and minability are very good. Boundaries for this unit could not be drawn from the field reconnaissance and limited laboratory testing and will require additional field studies for accurate delimitation.

Although additional investigations will be necessary, deposits bordering Class I and possibly Class II rock may qualify as Class I coarse aggregate sources.

4.1.1.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

Two Class II coarse aggregate sources were identified by test results. They are located in alluvial fan deposits (Aafs) and undifferentiated alluvial deposits (Au) in the northern portion of the Steptoe Valley study area. These deposits are typically moderately to well-graded, moderately well- to well-stratified, loose to medium-dense sandy gravel with subangular to subrounded clasts of limestone and/or sandstone. Sand-sized material ranges from 25 to 35 percent in tested samples. The alluvial fan sample showed acceptable abrasion test results but unacceptable soundness losses. The undifferentiated alluvial deposit sample had acceptable abrasion and soundness values but had deleterious potential alkali reactivity results. Overburden is generally less than 3 feet (0.9 m) and consists of poorly developed soil with Stage II to III caliche development. Access and minability are very good.

Additional Class II coarse aggregate sources mapped in Drawing 2 will require further investigation for accurate delineation. Class II coarse aggregate sources should also be available in alluvial fan (Aaf), older lacustrine (Aol) and undifferentiated alluvial (Au) deposits near Class I and Class II carbonate or quartzitic rocks.

4.1.1.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No unsuitable coarse aggregate sources were identified by laboratory testing in the study area during the valley-specific investigation.

4.1.2 Fine Aggregate

4.1.2.1 Potentially Suitable Concrete Aggregate or Road-Base Material Sources - Class I

Class I fine aggregate sources are located in alluvial fan (Aaf, Aafs) and undifferentiated alluvial (Au) deposits along the western margin of the Duck Creek Range in Steptoe Valley. The alluvial fan deposits are also mapped as a Class I coarse aggregate source (Section 4.1.1.1) and are therefore multiple sources (Drawing 2). These deposits are poorly to moderately graded, moderately well-stratified, loose to medium-dense sandy gravel with predominantly subangular clasts of limestone, dolomite, and quartzite. Gravel proportions range from 45 to 74 percent of the tested deposits. Laboratory results for fine aggregates indicate acceptable standards for soundness and alkali reactivity (two samples were found to be potentially deleterious). Over-burden consists of less than 3 feet (0.9 m) of soil with Stage I and II caliche development. Access and minability are very good. Boundaries of this source area are tentative, and further investigations will be necessary for more accurate definition.

The Class I fine aggregate source located in the undifferentiated alluvial deposit (Au) in the northern portion of the Steptoe Valley study area consists of moderately graded, well-stratified, loose to medium-dense sandy gravel with subangular to subrounded clasts of limestone. Where sampled, gravel comprises 63 percent of the deposits. Acceptable soundness losses were obtained but the sample had potentially deleterious

alkali reactivity results. Overburden consists of 2 feet (0.6 m) of soil with Stage II and III caliche development. Access and minability are very good. Limits of this source could not be defined without further investigations.

Although no other Class I fine aggregate sources were identified from laboratory tests within the study area, field observations indicate that additional Class I fine aggregate sources may exist adjacent to Class I and/or Class II crushed-rock sources.

4.1.2.2 Possible Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

Widespread Class II fine aggregate sources were identified from test results in most types of basin-fill deposits (Aaf, Aol, Aal) within the study area. Tested samples failed to meet acceptable Class I standards for soundness and/or alkali reactivity. The physical properties, composition, and source of these samples vary widely. They are typically poorly to moderately graded, moderately well-stratified, medium-dense sandy gravel composed of subangular to subrounded clasts of carbonate and/or volcanic rocks. Most Class II fine aggregate sources are associated with Class I coarse aggregate sources (Section 4.1.1.1). Field observations and laboratory test data for the sources are presented in Appendix A.

Class II fine aggregate sources are typically located in alluvial fan (Aaf) and older lacustrine (Aol) deposits basinward of Class I and Class II rock sources and should be available from most Class I and Class II basin-fill areas depicted in Drawing 2.

4.1.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

Class III fine aggregate sources are located in the central valley basins and are comprised predominantly of older lacustrine, recent playa, and to a lesser degree, alluvial fan and stream-channel and terrace deposits (Drawing 2). These sediments are typically interbeeded medium-dense fine sand and soft to stiff silt and clay. Locally, this mapped unit may contain appreciable sand and/or gravel or may covery coarser-grained deposts in the subsurface.

4.2 CRUSHED-ROCK SOURCES

4.2.1 Potentially Suitable Concrete Aggregate or Road-Base Material Sources - Class I

Class I crushed-rock aggregate sources are widespread throughout the area. Major exposures are located in the Egan, Schell Creek, and Duck Creek ranges. These sources consist predominantly of Paleozoic carbonate and clastic rocks. Mapped units consist of undifferentiated carbonate rocks (Cau) from the Guilmette Formation; limestone (Ls) from the Pogonip Grounp, the Joana, Ely, and undifferentiated Pennsylvania and Permian limestones, and undifferentiated upper Cambrian rocks; Laketown, Sevy, and Simonson dolomites (Do); and Prospect Mountain, Eureka, and Scotty Wash quartzites (Qtz). Granitic rock (Gr) is an additional, but limited Class I crushed-rock source.

The Devonian Guilmette Formation (Cau) is exposed within mountain ranges throughout the mapped area. The Guilmette consits of hard, think- to thick-bedded, fine- to medium-grained, medium-gray, interbedded limestone and dolomite. Laboratory tests

indicate acceptable standards for abrasion and soundness, but samples were not tested for potential alkali reactivity. Similar results were obtained in Dry Lake (FN-TR-37-a), White River (FN-TR-37-c), Hamlin (FN-TR-37-d), and Garden and Coal (E-TR-37-i) valleys. Splitting characteristics are favorable for crushing, and accessibility and minability are good to very good.

The Ordovician Pogonip Group (Ls) is also exposed throughout the area. It is typically moderately hard to hard, thin- to medium-bedded, fine-grained, medium-gray limestone. Acceptable test results were obtained for abrasion, soundness, and alkali reactivity. Splitting characteristics are poor due to the thin-bedded nature of much of the formation. Accessability and minability are generally good.

The Pennsylvanian Ely Limestone (Ls) is mapped as a separate Class I source in Lincoln County but is combined with the Class I undifferentiated Pennsylvanian and Permian limestone (Ls) in White Pine County. The Ely is a hard, thin- to medium-bedded, fine-grained, medium-gray limestone with favorable splitting characteristics. Tested samples exceed Class I standards for abrasion and soundness. However, this unit was not tested for alkali reactivity. Similar test results were reported from Ely Limestone samples collected in Dry Lake (FN-TR-37-a), Hamlin (FN-TR-37-d), Lake (FN-TR-37-f), and Garden and Coal (E-TR-37-i) valleys. Access and minability are generally good.

Undifferentiated upper Cambrian rocks (Ls) and the Mississippian *Joana Limestone (Ls) are also mapped* as Class I crushed-rock sources. These units were not tested in this study but were tested in nearby VSARS study area (Dry Lake, FN-TR-37-a; Lake, FN-TR-37-f; and Garden and Coal, E-TR-37-i) and found to meet Class I standards. Only limited and scattered exposures of the upper Cambrian rocks exist within the area. The Joana is mapped separately only in Lincoln County and is combined with Devonian and Mississippian clastic units (Su) in White Pine County.

The Silurian Laketown Dolomite (Do) is exposed throughout the area but is most abundant in Cave Valley. The unit consists of hard, thin- to medium-bedded, fine-grained, dark-gray to gray-brown dolomite. Laboratory tests show acceptable Class I abrasion and soundness results. The sample was not tested for potential alkali reactivity. The Laketown also exceeded Class I laboratory standards in Lake (FN-TR-37-f) and Garden and Coal (E-TR-37-i) valleys. Splitting characteristics, accessability, and minability are good.

The Devonian Sevy and Simonson dolomites (Do) were not tested within the study area but are mapped as Class I crushed-rock aggregate sources on the basis of test results from other nearby VSARS areas (Dry Lake, FN-TR-37-a; Hamlin, FN-TR-37-d; and Garden and Coal, E-TR-37-i). These units are typically hard, thin- to thick-bedded, fine-grained, light- to dark-gray dolomite *with favorable splitting characteristics.* Accessability and minability are good throughout most of the area.

The Cambrian Prospect Mountain Quartzite (Qtz) is exposed in the central part of the study area within the Schell Creek Range and in the northern part within the Duck Creek and Egan ranges. The Prospect Mountain is hard to very hard, thick-bedded, medium-grained, purplish-red to light-brown quartzite with only moderately favorable splitting characteristics. Abrasion and soundness tests indicate acceptable losses. The sample was not tested for alkali reactivity. Similar test results were obtained in Lake Valley (FN-TR-37-f). Access and minability are generally good.

The Ordovician Eureka Quartzite (Qtz) is exposed in isolated outcrops throughout the area. In Lincoln County, the Eureka is mapped separately as a Class I quartzite (Qtz). However, in White Pine County, the Eureka is combined with the Pogonip Group (Ls), a Class I limestone. (In northern Cave Valley, a Eureka Quartzite outcrop was tested and mapped separately based on field investigations). The Eureka is a hard- to very hard, thin- to thick-bedded, fine- to medium-grained, white to reddish-brown, vitreous quartzite with favorable splitting characteristics. Abrasion and soundness losses met Class I standards. No alkali reactivity tests were performed. Class I laboratory test results were also obtained from White River (FN-TR-37-c) and Garden and Coal (E-TR-37-i), however, excessive abrasion losses were obtained from a sample in Dry Lake (FN-TR-37-a). Accessability and minability vary from poor to good depending on location and exposure.

The Mississippian Scotty Wash Quartzite (Qtz) is exposed only within the Egan Range in west-central Cave Valley. This unit thins to the north and is not present in the northern part of the study area. The Scotty Wash consists of moderately hard to hard, thin- to medium-bedded, medium-grained, reddish-brown quartzitic sandstone. Abrasion and soundness losses were high (Appendix A) but within Class I limits. Potential alkali reactivity tests were not performed. Splitting characteristics, accessibility, and minability are considered good.

Granitic rock (Gr) in the Schell Creek Range in the extreme southern part of Cave Valley was sampled and found to be a Class I crushed-rock source. The unit is hard, moderately well-jointed, medium- to coarse-grained, brownish-gray diorite. Abrasion, soundness, and alkali reactivity test results meet Class I requirements. Splitting characteristics are favorable and access and minability are very good.

The Permian Arcturus Formation (Su) is exposed throughout the Steptoe Valley area. It is a moderately hard to hard, thin-bedded, light-gray, sandy limestone and yellow calcareous sandstone. A sample from a limestone bed in the Egan Range met acceptable Class I results for abrasion, soundness, and alkali reactivity. The lithologic variability of the Arcturus and the undifferentiated mapping of the arcturous and the Rib Hill Sandstone in much of Steptoe Valley prevents the delineation of this unit as a Class I source. Further investigations will be necessary to accurately define Class I boundaries of this

formation. Splitting characteristics are good but access and minability vary from poor to good depending on location.

4.2.2 Possible Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

A Class II crushed-rock source was identified in the Permian Park City Group (Su) in the Schell Creek Range near southern Steptoe Valley. The sampled unit consists of hard, thin- to thick-bedded, fine-grained limestone with moderate splitting characteristics. Acceptable abrasion and soundness results were obtained but the sample had deleterious alkali reactivity test results. Access and minability are poor to good.

The remainder of rock units mapped as Class II in Drawing 2 were classified only by field visual observations. The predominant units are the Precambrian McCoy Creek Group (Qtz), the Cambrian Pole Canyon Limestone (Ls) and Patterson Pass Shale (Su), the Mississippian Chainman Shale (Su), undivided Devonian and Mississippian rocks (Su), the sandstone member (Su) of the Pennsylvanian Ely Limestone, the Permian unnamed limestone (Ls), the Rib Hill and Arcturus formations (Su), the undifferentiated volcanic rocks (Vu), and the Tertiary fanglomerate (Su).

4.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No Class III crushed-rock sources were identified by laboratory testing within the study area during this investigation.

5.0 CONCLUSIONS

Results of the valley-specific aggregate investigation indicate that sufficient supplies of potentially good- to high-quality (Class I and II) basin-fill and crushed-rock aggregate materials are available within the Cave and Steptoe valleys study area to meet construction requirements of the MX system (Drawing 2).

5.1 POTENTIAL BASIN-FILL AGGREGATE SOURCES

5.1.1 Coarse Aggregate

Extensive Class I coarse aggregate deposits, listed in order of potential suitability, have been identified within the following areas:

a. Alluvial fan deposits (Aafs, Aaf) along the east and west sides of the central and northern Steptoe Valley study area;

b. Alluvial fan deposits (Aafs) in southern Cave Valley; and

c. Older lacustrine deposits (Aols) in southern Cave Valley.

Field observations indicate additional sources of Class I coarse aggregates may be available in alluvial fan (Aaf) or older lacustrine (Aol) deposits adjacent to the rock/alluvium contact of Class I and/or Class II crushed-rock sources.

Potentially suitable Class II coarse aggregate sources are widespread in the study area. They are typically located within alluvial fan (Aaf), older lacustrine (Aol), and undifferentiated alluvial (Au) deposits flanking Class I and/or Class II rock sources.

5.1.2 Fine Aggregate

While most coarse aggregate sources will supply quantities of fine aggregate either from the natural deposits or during processing, Class I fine aggregate (multiple) sources were identified in alluvial fan (Aaf, Aafs) and undifferentiated alluvial (Au) deposits in the northeastern Steptoe Valley study area.

Further field reconnaissance would be required to identify and delineate additional Class I fine aggregate sources. However, based on field observations, potential sources may exist in alluvial fan (Aaf) and older lacustrine (Aol) deposits derived from Class I and/or Class II rock sources.

Extensive Class II fine aggregate sources are generally found basinward of most Class I and Class II rock units.

5.2 POTENTIAL CRUSHED-ROCK AGGREGATE SOURCES

Class I crushed-rock sources are generally exposed throughout the study area. The most suitable units are:

a. Undifferentiated carbonate rocks (Cau) from the Guilmette Formation;

b. Limestone (Ls) from the Pogonip Group, the Joana and Ely limestones, and undifferentiated upper Cambrian, Pennsylvanian, and Permian rocks;

c. Dolomite (Do) from the Laketown, Sevy, and Simonson dolomites;

d. Quartzite (Qtz) from the Prospect Mountain, Eureka, and Scotty Wash quartzites; and

e. Granitic rock (Gr) in southern Cave Valley.

Other rock units (i.e., quartzite, limestone, dolomite, and undifferentiated carbonate or sedimentary units) within the

study area may provide significant quantities of Class I crushed rock. Undifferentiated volcanic units exhibit greater variability but may produce localized Class I crushed-rock aggregates sources. The majority of the rock units within the study area can be expected to meet Class II requirements.

6.0 BIBLIOGRAPHY

American Concrete Association, 1975, Durability of concrete, American Concrete Institute Publication, SP-47, p. 385

American Concrete Institute, 1977, Recommended practice for selecting proportions for normal and heavyweight concrete, American Concrete Institute, 20 p.

__________, 1978, Cement and concrete terminology, American Concrete Institute Publication, SP. 19 (78), p. 50

American Public Works Association, 1970, Standard specifications for public works construction: Part 2, Construction Materials, Sec. 200 Rock Materials, p. 62-70.

American Society for Testing and Materials, 1975, Significance of tests and properties of concrete and concrete-making materials, American Society for Testing and Materials, Special Technical Publication No. 169-A, p. 571.

__________, 1978, Annual book of ASTM standards, Part 14, Concrete and Mineral Aggregates, p. 814.

Bates, R. L., 1969, Geology of the industrial rocks and minerals, New York Dover Publications, Inc., p. 459.

Blanks, R., and Kennedy, H., 1955, The technology of cement and concrete, John Wiley & Sons, Inc., v. 1, p. 422.

Brokaw, A., and Heidrick, T., 1960, Geologic map and section of the Girou Wash quadrange, White Pine County, Nevada, U.S. Geological Survey Map, GQ-476.

Brokaw, A. L., and Barosh, P. J., 1968, Geologic map of the Rieptown quadrangle, White Pine County, Nevada, U.S. Geological Survey Map, GQ-750.

Brokaw, A. L., Bauer, H. L., and Breitrick, R. A., 1973, Geologic map of the Ruth quadrangle, White Pine County, Nevada, U.S. Geological Survey Map, GQ-1085.

Brokaw, A. L., and Shawe, D. R., 1965, Geologic map and sections of the Ely SW quadrangle, White Pine County, Nevada, U.S. Geological Survey Map, I-449.

Brown, L., 1959, Petrography of cement and concrete, Portland Cement Research Department, Bulletin 111.

Eakin, Thomas E., 1962, Ground-water appraisal of Cave Valley in Lincoln and White Pine Counties, Nevada, Nevada Department of Conservation and Natural Resources, Ground-water Resources - Reconnaissance Series Report, 13, p. 18.

Eakin, T. E., Hughes, J. L., and Moore, D. O., 1967, Water-resources appraisal of Steptoe Valley, White Pine and Elko Counties, Nevada, Nevada Department of Conservation and Natural Resources, Ground-water Resources - Reconnaissance Series Report, 42, p. 47.

Erlin, B., 1966, Methods used in petrographic studies of concrete, Portland Cement Association, Research Department Bulletin 193, p. 17.

Ertec Western, Inc., 1981, Aggregate resources study, Garden and Coal valleys, Nevada, Ertec Western Report, E-TR-37-i, p. 43.

__________, (in progress), Verification Studies, Cave Valley, Nevada, Ertec Western Report, E-TR-27-CV.

__________, (in progress), Verification studies, Steptoe Valley, Nevada, Ertec Western Report, E-TR-27-SO.

Fenneman, N. M., and Johnson, D. W., 1946, Physical divisions of the *United* States, *U.S.* Geological Survey map, scale 1:7,000,000.

Freedman, S., 1971, High strength concrete, Portland Cement Association, concrete Information Reprint, p. 17.

Fugro National, Inc., 1978, Aggregate resources report, Department of Defense and Bureau of Land Management lands, southwestern United States, FN-TR-20D, p. 85.

__________, 1980, Aggregate Resources Report, Utah-Nevada study area, Fugro National Report FN-TR-34, p. 36.

__________, 1980 Aggregate resources study, Dry Lake, Muleshoe, Delamar, and Pahroc valleys, Nevada, Fugro National Report FN-TR-37-a, p. 45.

__________, 1980, Aggregate resources study, White River Valley, Nevada, Fugro National Report, FN-TR-37-c, p. 44.

__________, 1980, Aggregate resources study, Hamlin Valley, Nevada-Utah, Fugro National Report, FN-TR-37-d, p. 44.

__________, 1981, Aggregate resources study, Lake Valley, Nevada, Fugro National Report, FN-TR-37-f, p. 40.

Gile, L. H., 1961, A classification of Ca horizons in soils in a desert region, Dona Ana County, New Mexico, Soil Science Society America Procedures, v. 25, No. 1, p. 52-61.

Hadley, D. W., 1961, Alkali reactivity of carbonate rocks-expansion and dedolomitization, Research and Development Laboratories of the Portland Cement Association, Bulletin 139, p. 462-474.

Hadley, D. W., 1964, Alkali reactivity of dolomitic carbonate rocks, Research and Development Laboratories of the Portland Cement Association, Bulletin 176, p. 19.

_____________, 1968, Field and laboratory studies on the reactivity of sand-gravel aggregates, Research and Development Laboratories of the Portland Cement Association, Bulletin 221, p. 17-33.

Hose, R. K., Blake, M. C., Jr., and Smith, R., 1976, Geology and mineral resources of White Pine County, Nevada: Nevada Bureau of Mines and Geology, Bulletin 85, p. 105.

Howard, E. L., compiler, 1978, Geologic map of the eastern Great Basin, Nevada and Utah, Terra Scan Group LTD., 3 sheets.

Kellogg, Harold E., 1964, Cenozoic stratigraphy and structure of the southern Egan Range, Nevada, Geological Society America Bulletin 75:949-968.

Ketner, K. B., 1976, Map showing high-purity quartzite in California, Nevada, Utah, Idaho and Montana, U.S. Geological Survey Map, MF-821.

Kleinhampl, Frank J., and Ziony, J. I., 1967, Preliminary geologic map of northern Nye County, Nevada, U. S. Geological Survey Open File Map.

Lerch, W., 1959, A cement-aggregate reaction that occurs with certain sand-gravel aggregates, Research and Development Laboratories of the Portland Cement Association, Bulletin 122, p. 42-50.

McKee, E. D., and Weir, G. W., 1953, Terminology for stratification and cross-stratification in sedimentary rocks, Geological Society American Bulletin, v. 64, p. 381-389.

Murphy, J. B., Nichols, S. L., and Schilling, J. H., No date, Rockhound map of Nevada, Nevada Bureau of Mines and Geology, special publication 1.

National Ready Mixed Concrete Association, 1961, Selection and use of aggregate for concrete, National Ready Mixed Concrete Association, Publication No. 101, p. 513-542.

National Sand & Gravel Association, 1977, Compilation of ASTM standards relating to sand, gravel and concrete, NSGA Circular No. 113, NRMCA Publication No. 137.

Nevada Department of Highways, No date, Materials and research laboratory, aggregate test data, unpublished.

Office of State Inspector of Mines, 1977, Directory of Nevada mine operations active during calander year 1976, Nevada Industrial Commission, p. 59.

Papke, G. K., 1973, Industrial mineral deposits of Nevada, Nevada Bureau of Mines and Geology, map 46.

Pickett, G., 1956, Effect of aggregate on shrinkage of concrete and hypothesis concerning shrinkage, Portland Cement Association, Research Department, Bulletin 66, p. 5.

Powers, T. C., and Steinour, H. H., 1955, An interpretation of published researches on the alkali-aggregate reaction, Research and Development Laboratories of the Portland Cement Association, Bulletin 55, Part I and II, p. 497, 785.

Reid, J. A.. 1904, Preliminary report on the building stones of Nevada, including a brief chapter on road metal, University of Nevada Department of Geology and Mining, v. 1, no. 1, p.57.

Roper, H., 1960, Volume changes of concrete affected by aggregate type: Portland Cement Association, Research Department Bulletin 123, p. 4.

Synder, C. T., Hardman, George, and Zdenek, F. F., 1964, Pleistocene lakes in the Great Basin, U.S. Geological Survey Map, I-416.

Steinour, H. H., 1960, Concrete mix water--how impure can it be? Research and Development Laboratories of the Portland Cement Association, Bulletin 119, p. 33-50.

Stewart, H., and Carlson, J. E., 1978, Geologic map of Nevada, U.S. Geological Survey Map, scale 1:500,000.

Travis, R. B., 1955, Classification of rocks, Quarterly of the Colorado School of Mines, v. 50, No. 1, p. 98.

Tschanz, C. M., and Pamepyan, E. H., 1970, Geology and mineral deposits of Lincoln County, Nevada, Nevada Bureau of Mines Bulletin 73, p. 188.

U. S. Army Corps of Engineers, 1953, Test data, concrete aggregate in continental U.S.. U. S. Army Corps of Engineers v. 1, areas 2 and 3.

U. S. Bureau of Land Management, 1974, Nevada BLM Statistics (1974), U. S. Department of Interior, p. 20.

U. S. Department of the Interior, 1975, Concrete Manual, Water Resources Technical Publication, p. 627.

__________, 1974, The mineral industry of Nevada, Bureau of Mines.

U.S. Department of the Interior, 1966, Concrete Manual: A manual for the control of concrete construction, Bureau of Reclamation, p. 642.

__________, Lower Colorado Regional Office, Nevada Aggregate Data, unpublished.

__________, 1974, Earth Manual, U. S. Department of the Interior, Bureau of Reclamation, p. 810.

__________, 1975, Concrete Manual: U. S. Department of the Interior, Bureau of Reclamation, p. 627.

U. S. Geological Survey, 1964, Mineral and water resources of Nevada: U. S. Government Printing Office, Washington, p. 314.

Voskuil, W. H., 1966, Selected readings in mineral economics, Nevada Bureau of Mines, Report 12, p. 18.

Waddell, J., 1976, Concrete inspection manual, International Conference of Building Officials, p. 332.

Womack, J. C., and others, 1963, Materials manual, California Highway Transporation Agency, v. I and II.

APPENDIX A

ERTEC WESTERN FIELD STATION AND SUPPLEMENTARY TEST DATA AND EXISTING TEST DATA SUMMARY TABLES CAVE AND STEPTOE VALLEYS, NEVADA

EXPLANATION OF ERTEC WESTERN FIELD STATION AND SUPPLEMENTARY TEST DATA

Ertec Western field stations were established at locations throughout the valley-specific study area where detailed descriptions of potential basin-fill or rock aggregate sources were recorded (Drawing 1). All field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Data entries record conditions at specific field station locations that have been generalized in the text and Drawing 2. Detailed explanations for the column headings in Table A-1 are as follows:

Column Heading	Explanation
Map Number	This sequentially arranged numbering system was established to facilitate the labelling of Ertec Western field station locations and existing data sites on Drawing 1 and to list the correlating information on Tables A-1 and A-2 in an orderly arrangement.
Field Station	Ertec Western field station data are comprised of information collected during: o The Valley-Specific Aggregate Resources Study; sequentially numbered field stations were completed by two investigative teams (A and B). o The general aggregate investigation in Utah (UGS). o The Verification study in Cave and Steptoe valleys; trench data (CV-T or SO-T) were restricted to information below the soil horizon 3 to 6 feet (1 to 2 m).
Location	Lists major physiographic or cultural features in/or near field stations or existing data in which sites are situated.

Column Heading	Explanation
Geologic Unit	Generalized basin-fill or rock geologic units at field station or existing data locations. Thirteen classifications, emphasizing age and lithologic distinctions, were developed from existing geologic maps to accommodate map scale of Drawing 2.
Material Description	Except in cases where soil or rock samples were classified on laboratory results, the descriptions are based on field visual observations utilizing the Unified Soil Classification System (see Appendix C for detailed USCS information).
Field Observations	
Boulders and/or Cobbles, Percent	The estimated percentage of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an average diameter between 3 and 12 inches (8 and 30 cm); boulders have an average diameter of 12 inches (30 cm) or more.
Gravel	Particles that will pass a 3-inch (76-mm) and are retained on No. 4 (4.75 mm) sieve.
Sand	Particles passing No. 4 sieve and retained on No. 200 (0.075 mm) sieve.
Fines	Silt or clay soil particles passing No. 200.
Plasticity (Index)	Plasticity index is the range of water content, expressed as percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Field classification followed standard descriptions and their ranges are as follows: None - Nonplastic (NP) (PI, 0 - 4) Low - Slightly plastic (PI, 4 - 15) Medium - Medium plastic (PI, 15 - 30) High - Highly plastic (PI, > 31)
Hardness	A field test to identify materials that are soft or poorly bonded by estimating their resistance to impact with a rock hammer; classified as either soft, moderately hard, hard, or very hard.

Column Heading	Explanation
Weathering	Changes in color, texture, strength, chemical composition or other properties of rock outcrops or rock particles due to the action of weather; field classified as either fresh or slight(ly), moderate(ly), or very weathered.
Deleterious Materials	Substances potentially detrimental to concrete performance that may be present in aggregate; includes organic impurities, low-density material, (ash, vesicules, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche coatings, clay coatings, mica, gypsum, pyrite, chlorite, and friable materials, also, aggregate that may react chemically or be affected chemically by other external influences.

Laboratory Test Data

Sieve Analysis (ASTM C 136)	The determination of the proportions of particles lying within certain size ranges in granular material by separation on sieves of different size openings; 3-inches, 1 1/2-inches, 3/4-inch, 3/8-inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100 and No. 200.
No. 8, No. 16, No. 30, No. 50	Asterisked entries used No. 10, No. 20, No. 40, and No. 60 sieves, respectively.
Abrasion Test (ASTM C 131)	A method for testing abrasion resistance of an aggregate by placing a specified amount in a steel drum (the Los Angeles testing machine), rotating it 500 times, and determing the material worn away.
Soundness Test (ASTM C 88) CA, FA	CA = Coarse Aggregate FA = Fine Agregate The testing of aggregates to determine their resistance to disintegration by saturated solutions of magnesium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate information is not available from service records of the material exposed to actual weathering conditions.

Column Heading	Explanation
Specific Gravity and Absorption (ASTM C 127 and 128)	Methods to determine the Bulk Specific Gravity, Bulk SSD Specific Gravity (Saturated - Surface Dry Basis), and Apparent Specific Gravity and Absorption as defined in ASTM E12-70 and ASTM C 125, respectively.
Alkali Reactivity (ASTM C 289)	This method covers chemical determination of the potential reactivity of an aggregate with alkalies in portland cement concrete as indicated by the amount of reaction during 24 hours at 80°C between 1 N sodium hydroxide solution and aggregate that has been crushed and sieved to pass a No. 50 (300 m) sieve and be retained on a No. 100 (150 m) sieve.
Aggregate Use	I = Class I; potentially suitable concrete aggregate and road-base material source II = Class II; possibly unsuitable concrete aggregate/potentially suitable road-base material source III = Class III; unsuitable concrete aggregate or road base material source c = coarse aggregate f = fine aggregate f/c = fine and coarse aggregate cr = crushed rock All sources not specifically identified as Class I, II, or III from the abrasion, soundness, or alkali reactivity tests or the content of clay- and silt-sized particles, are designated as Class II sources.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRI MATERI THAN PE
							GRAVEL
1	CV-A1	Cave Valley	Gr	Diorite Intrusive			
2	CV-A2	Cave Valley	Aols	Sandy Gravel	GW-GM		
3	CV-A3	Schell Creek Range	Do	Dolomite			
4	CV-A4	Schell Creek Range	Cau	Dolomite			
5	CV-A5	Schell Creek Range	Do	Dolomite			
6	CV-A6	Schell Creek Range	Do	Dolomite			
7	CV-A7	Schell Creek Range	Qtz	Quartzite			
8	CV-A8	Egan Range	Do	Dolomite			
9	CV-A9	Cave Valley	Ls	Limestone			
10	CV-A10	Egan Range	Qtz	Quartzite			
11	CV-A11	Egan Range	Ls	Limestone			
12	CV-A12	Cave Valley	Aafs	Sandy Gravel	GW-GM		
13	CV-A13	Egan Range	Vu	Quartz Latite			
14	CV-A14	Cave Valley	Ls	Limestone			

FIELD OBSERVATIONS						SIEVE ANALYSIS, PERCENT PASSING (ASTM C 13								
IBUTION OF IAL FINER COBBLES, ERCENT		PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS									
SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50
			Hard	Slight	10% Biotite									
		None			Minor Caliche	100	98.1	85.4	63.1	34.2	18.0	11.7	10.0	9.
			Hard	Slight	None									
			Hard	Slight to Mod.	Calcite Veins									
			Hard	Slight	None									
			Hard	Slight	None									
			Very Hard	Slight	Locally Brecciated									
			Hard	Slight	None									
			Hard to Very Hard	Slight	<5% Chert, <5% Low Density Sandstone									
			Hard to Mod.	Slight	Some Interbedded Shale									
			Hard	Slight	5 - 10% Chert									
		None			10% Chert, 5% Low Density Volcanics	100	94.9	76.9	50.6	35.8	27.5	20.8	15.3	10
			Mod.	Mod.	Low Density Volcanics									
			Mod. to Hard	Slight	5 - 10% Chert									

LABORATORY TEST DATA

	C 136)			ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)	
							COARSE AGGREGATE				FINE AGGREGATE					
							SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION		
	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA
				31.8	7.8		2.51	2.57	2.68	2.50					Innocuous	
	9.1	8.2	6.8	32.6	6.9	20.3										
				30.6	2.1											
				46.0	15.7											
3	10.7	7.8	5.5	25.8	8.8	20.0	2.39	2.48	2.62	3.70	2.32	2.43	2.61	4.87	Innocuous	
				32.4	1.3										Innocuous	

Ertec
The Earth Technology Corp

ERTEC W
AND SUP
CAVE AND S

28 SEPT 81

3

ATORY TEST DATA

SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
PERCENT LOSS		COARSE AGGREGATE				FINE AGGREGATE						
		SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
CA	FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA	
7.8		2.51	2.57	2.68	2.50					Innocuous		Icr Ic
6.9	20.3											IIf
												IIcr
												IIcr
												IIcr
2.1												Icr
												IIcr
												IIcr
												IIcr
15.7												Icr
												IIcr
8.8	20.0	2.39	2.48	2.62	3.70	2.32	2.43	2.61	4.87	Innocuous		Ic IIf
												IIcr
1.3										Innocuous		Icr

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

ERTEC WESTERN FIELD STATION
AND SUPPLEMENTARY TEST DATA
CAVE AND STEPTOE VALLEYS, NEVADA

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
15	CV-A15	Cave Valley	Su	Conglomerate					
16	CV-A16	Egan Range	Cau	Limestone & Dolomite					
17	CV-A17	Cave Valley	Aafs	Sandy Gravel	GW-GM				
18	CV-A18	Schell Creek Range	Qtz	Quartzite					
19	CV-A19	Cave Valley	Aalf	Silt with Sand & Gravel	ML				
20	CV-A20	Cave Valley	Su	Conglomerate					
21	CV-A21	Schell Creek Range	Qtz	Quartzite					
22	DL-B2	Schell Creek Range	Cau	Limestone					
23	SO-A1	Egan Range	Su	Limestone					
24	SO-A2	Egan Range	Vu	Dacitic Ash-flow Tuff					
25	SO-A3	Steptoe Valley	Aalf	Sandy Gravel	GP-GM				
26	SO-A4	Steptoe Valley	Aafs	Sandy Gravel	GW-GM				
27	SO-A5	Steptoe Valley	Aafs	Gravelly Sand	SP-SM				

FIELD OBSERVATIONS													
				SIEVE ANALYSIS, PERCENT PASSING (ASTM C 136)									
PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100
	Mod.	Mod.	5% Volcanics, Chert										
	Hard	Slight	Calcite veins										
None			5 - 10% Chert	100	97.4	85.6	68.9	49.2	32.9	21.6	15.7	11.6	9.3
	Hard to Very Hard	Slight	None										
Low			70% Silt										
	Mod.	Mod.	70% Low Density Volcanic Clasts										
	Hard to Very Hard	Slight	None										
	Very Hard	Slight	None										
	Mod.	Slight	Marly, Shaley										
	Hard	Slight to Mod.	25% Biotite										
None			Minor Caliche	93.2	84.7	73.0	58.8	43.5	33.5	24.8	19.2	15.0	12.3
None			5% Chert, 5% Low Density Sandstone	92.5	85.9	74.9	57.1	42.1	32.3	22.1	15.5	11.0	8.2
None			Minor Caliche		100	97.2	84.6	58.3	35.9	21.1	14.2	11.0	9.6

v

LABORATORY TEST DATA

NO. 100	NO. 200	ABRASION TEST (ASTM C 131) PERCENT WEAR	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS CA	SOUNDNESS TEST PERCENT LOSS FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY BULK	COARSE AGGREGATE BULK SSD	COARSE AGGREGATE APPARENT	COARSE AGGREGATE PERCENT ABSORPTION	FINE AGGREGATE SPECIFIC GRAVITY BULK	FINE AGGREGATE BULK SSD	FINE AGGREGATE APPARENT	FINE AGGREGATE PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	ALKALI REACTIVITY FA	AGGREGATE USE
															IIcr
		25.6	1.0												Icr
9.3	7.5	26.1	7.2	17.7									Innocuous		Ic
															IIf
		26.8	0.5												Icr
															IIf
															IIc
		33.7	2.0												Icr
															IIc
															IIc
															IIc
12.3	9.8	27.2	5.3	22.5											Ic
															II
8.2	5.0	31.0	8.6	20.6	2.53	2.59	2.68	2.22	2.52	2.57	2.64	1.83	Innocuous		Ic
															II
9.6	8.1	35.5	9.0	24.8											II
															Ic

3

TORY TEST DATA

SOUNDNESS TEST (ASTM C 88) PERCENT LOSS		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
		COARSE AGGREGATE				FINE AGGREGATE						
		SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
CA	FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA	
												IIcr
1.0												Icr
7.2	17.7									Innocuous		Ic IIf
0.5												Icr
												IIf
												IIcr
2.0												Icr
												IIcr
												IIcr
												IIcr
5.3	22.5											Ic IIf
8.6	20.6	2.53	2.59	2.68	2.22	2.52	2.57	2.64	1.83	Innocuous		Ic IIf
9.0	24.8											IIf Ic

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
28	SO-A6	Steptoe Valley	Aafs	Silty Gravel with Sand	GM				
29	SO-A7	Steptoe Valley	Aafs	Silty Gravel with Sand	GM				
30	SO-B1	Steptoe Valley	Aaf	Sandy Gravel	GP-GM				
31	SO-B2	Steptoe Valley	Aaf	Gravelly Sand	SP-SM				
32	SO-B3	Heusser Mountain	Qtz	Quartzite					
33	SO-B4	Steptoe Valley	Au	Sandy Gravel	GW				
34	SO-B5	Steptoe Valley	Aaf	Sandy Gravel	GW-GM				
35	SO-B6	Duck Creek Range	Ls	Limestone					
36	SO-B7	Steptoe Valley	Aaf	Silty Gravel with Sand	GM				
37	SO-B8	Duck Creek Range	Do	Limestone & Dolomite					
38	SO-B9	Duck Creek Range	Cau	Limestone					
39	SO-B10	Schell Creek Range	Su	Limestone					
40	SO-B11	Schell Creek Range	Ls	Limestone					

FIELD OBSERVATIONS														
FINES	PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (ASTM C 136)									
					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100
	Low			5% Chert	100	95.9	88.8	74.3	55.1	43.8	34.8	29.0	24.4	20.9
	None			5% Chert, 5% Low Density Material		100	97.4	84.4	55.4	41.2	31.0	24.9	20.8	16.7
	None			Caliche	100	90.4	77.6	61.8	47.9	37.0	26.5	18.8	11.9	8.3
	Low			Chert										
		Hard	Slight	None										
	None			<5% Shale	100	91.4	75.1	55.1	37.3	27.9	19.8	14.4	6.4	3.4
	None			Caliche	100	93.7	80.0	62.3	48.7	34.0	23.5	18.3	14.3	11.2
		Hard	Mod.	Calcite Veins										
	None			Caliche		100	91.5	73.2	54.9	43.4	35.1	29.4	23.6	19.5
		Hard to Very Hard	Slight	Chert										
		Hard	Slight	Calcite Veins, Mineralization										
		Hard	Slight	None										
		Hard	Slight	Chert										

LABORATORY TEST DATA

[illegible]	NO. 200	ABRASION TEST (ASTM C 131) PERCENT WEAR	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS CA	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY BULK	COARSE AGGREGATE SPECIFIC GRAVITY BULK SSD	COARSE AGGREGATE SPECIFIC GRAVITY APPARENT	COARSE AGGREGATE PERCENT ABSORPTION	FINE AGGREGATE SPECIFIC GRAVITY BULK	FINE AGGREGATE SPECIFIC GRAVITY BULK SSD	FINE AGGREGATE SPECIFIC GRAVITY APPARENT	FINE AGGREGATE PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	ALKALI REACTIVITY (ASTM C 289) FA	AGGREGATE USE
.9	16.3	25.3	7.2	24.2											Ic IIf
6.7	12.3	36.3	11.4	31.5											Ic IIf
8.3	5.7	27.2	6.7	20.2											Ic IIf
															IIf/c
															IIcr
3.4	2.5	25.6	3.5	9.8									Deleterious	Potentially Deleterious	IIc If
1.2	8.0	30.7	1.7	10.9	2.73	2.75	2.78	0.77	2.64	2.69	2.78	1.94	Innocuous	Innocuous	Ic/f
															IIcr
9.5	15.4	23.2	0.9	5.6	2.60	2.62	2.65	0.75	2.57	2.65	2.77	2.80	Innocuous	Innocuous	Ic/f
															IIcr
		28.9	2.7												Icr
		24.8	1.4										Deleterious		IIcr
		23.2	1.2												Icr

Ertec
The Earth Technology Corporation

MX SITI
DEPARTME
B

ERTEC WESTERN FIEL
AND SUPPLEMENTARY
CAVE AND STEPTOE VAL

25 SEPT 81 PAGE 3 OF

3

TORY TEST DATA

SOUNDNESS TEST (ASTM C 88) PERCENT LOSS		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY				FINE AGGREGATE SPECIFIC GRAVITY				ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
CA	FA	BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	CA	FA	
7.2	24.2											Ic IIf
11.4	31.5											Ic IIf
6.7	20.2											Ic IIf
												IIf/c
												IIcr
3.5	9.8									Deleterious	Potentially Deleterious	IIc If
1.7	10.9	2.73	2.75	2.78	0.77	2.64	2.69	2.78	1.94	Innocuous	Innocuous	Ic/f
												IIcr
0.9	5.6	2.60	2.62	2.65	0.75	2.57	2.65	2.77	2.80	Innocuous	Innocuous	Ic/f
												IIcr
2.7												Icr
1.4										Deleterious		IIcr
1.2												Icr

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

ERTEC WESTERN FIELD STATION
AND SUPPLEMENTARY TEST DATA
CAVE AND STEPTOE VALLEYS, NEVADA

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
41	SO-B12	Steptoe Valley	Aalg	Sandy Gravel	GP-GM				
42	SO-B13	Steptoe Valley	Aafs	Sandy Gravel	GP-GM				
43	SO-B14	Egan Range	Su	Limestone					
44	SO-B15	Steptoe Valley	Aafs	Sandy Gravel	GP-GM				
45	SO-B16	Egan Range	Vu	Rhyolitic Ash-flow Tuff					
46	SO-B17	Steptoe Valley	Aafs	Sandy Gravel	GP-GM				
47	SO-B18	Egan Range	Su	Limestone					
48	SO-B19	Egan Range	Vu	Rhyolitic Ash-flow Tuff					
49	SO-B20	Egan Range	Ls	Limestone					
50	SO-B21	Egan Range	Aaf	Sandy Gravel	GW				
51	NV-R-39	Schell Creek Range	Ls	Limestone with Interbedded Dolomite					
52	NV-R-40	Steptoe Valley	Au	Sandy Gravel	GP				
53	NV-R-41	Steptoe Valley	Au	Sandy Gravel/ Gravelly Sand	SP-SM/ GP-GM		45	45	10

FINES	FIELD OBSERVATIONS				SIEVE ANALYSIS, PERCENT PASSING (ASTM C 136)									
	PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100
	None			Friable Sandstone & Siltstone	100	98.0	87.9	64.3	39.1	25.6	18.8	14.9	11.5	9.0
	None			Friable Sandstone, Caliche	95.2	86.1	65.2	43.5	30.6	26.1	22.2	18.9	14.3	9.8
		Mod. to Hard	Slight to Mod.	Chert										
	None			Volcanic Glass, Friable Sandstone	96.2	84.8	68.9	49.1	34.1	24.9	19.1	15.9	13.5	11.7
		Mod.	Mod.	Low Density Volcanics, Mica										
	Low			Caliche	100	97.8	91.3	69.6	45.4	29.8	21.8	18.1	14.6	11.5
		Hard	Slight	None										
		Mod. to Hard	Slight to Mod.	Low Density Volcanics, Mica										
		Hard	Slight	Chert (Locally Abundant)										
	None			Caliche	94.0	75.9	57.8	39.0	26.3	18.4	11.2	7.0	4.9	4.2
		Hard												
	None			10% Volcanic Glass		96.6	81.7	57.9	37.1	24.9	17.3	8.7		
10	None			15% Volcanic Glass										

2

LABORATORY TEST DATA

NO. 100	NO. 200	ABRASION TEST (ASTM C 131) PERCENT WEAR	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS CA	SOUNDNESS TEST PERCENT LOSS FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY BULK	COARSE AGGREGATE BULK SSD	COARSE AGGREGATE APPARENT	COARSE AGGREGATE PERCENT ABSORPTION	FINE AGGREGATE SPECIFIC GRAVITY BULK	FINE AGGREGATE BULK SSD	FINE AGGREGATE APPARENT	FINE AGGREGATE PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	ALKALI REACTIVITY FA	AGGREGATE USE
9.0	7.2	33.9	8.3	26.6											Ic IIf
9.8	5.5	25.4	15.3	28.6											IIc/
		23.8	0.4		2.68	2.70	2.72	0.55					Innocuous		Icr
11.7	9.2	28.6	6.8	24.5											Ic IIf
															IIcr
11.5	8.8	32.1	7.5	28.2											Ic IIf
															IIcr
															IIcr
															IIcr
4.2	3.5	25.1	2.4	13.7									Innocuous	Potentially Deleterious	Ic/
															IIc
															IIc
															IIc

3

ATORY TEST DATA

SOUNDNESS TEST (ASTM C 88) PERCENT LOSS CA	FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	FINE AGGREGATE SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	FA	AGGREGATE USE
8.3	26.6											Ic IIf
15.3	28.6											IIc/f
0.4		2.68	2.70	2.72	0.55					Innocuous		Icr
6.8	24.5											Ic IIf
												IIcr
7.5	28.2											Ic IIf
												IIcr
												IIcr
												IIcr
2.4	13.7									Innocuous	Potentially Deleterious	Ic/f
												IIcr
												IIc/f
												IIc/f

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	FIELD OBS					
						BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS
							GRAVEL	SAND	FINES		
54	NV-R-42	Egan Range	Cau	Limestone							Hard
55	NV-R-43	Egan Range	Ls	Limestone							Hard
56	NV-H-31	Duck Creek Range	Qtz	Quartzite							Hard
57	NV-H-32	Duck Creek Range	Ls	Limestone							Mod. Hard
58	NV-H-33	Heusser Mountain	Ls	Limestone							Hard
59	CV-T-1	Cave Valley	Aafs	Sandy Gravel	GP						
60	CV-T-5	Cave Valley	Aols	Silty Sand	SM						
61	CV-T-6	Cave Valley	Aolf	Silty Sand	SM						
62	SO-T-1	Steptoe Valley	Aafs	Silty Gravel with Sand	GM						
63	SO-T-3	Steptoe Valley	Aafs	Gravelly Sand	SP						

OBSERVATIONS			LA											
HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (ASTM C 136)											ABRASION TEST
			3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR
Hard		Chert												
Hard		Minor Chert												
Hard														
Mod. Hard		Calcite												
Hard		Calcite												
			100	74.2	62.7	50.4	43.8	*37.8	*33.2	*28.8	*18.5	7.8	3.8	
							100	*99.9	*99.0	*98.1	*92.4	66.5	39.7	
				100	92.9	91.1	89.4	*85.5	*77.1	*64.3	*55.3	47.5	37.0	
				100	87.0	67.9	49.0	*36.0	*27.7	*23.4	*20.3	18.2	14.1	
				100	95.5	83.4	74.7	*59.1	*35.0	*19.6	*11.1	7.2	4.9	

v

LABORATORY TEST DATA

ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
			COARSE AGGREGATE				FINE AGGREGATE						
			SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA	
													IIcr
													IIcr
													IIcr
													IIcr
													IIcr
													IIc/f
													IIf
													IIf
													IIc/f
													IIf

Ertec
The Earth Technology Corporation

MX SITING INVESTIGAT
DEPARTMENT OF THE AIR
BMO/AFRCE-MX

ERTEC WESTERN FIELD STATION
AND SUPPLEMENTARY TEST DATA
CAVE AND STEPTOE VALLEYS, NEVAD

25 SEPT 81 PAGE 5 OF 5 TA

3

EXPLANATION OF EXISTING DATA

Existing data pertaining to aggregates were extracted from the State of Nevada Department of Highways. These reports are compilations of available site data from existing files and records and are intended to accurately locate, investigate, and catalog materials needed for highway construction. Explanations for column headings which appear in Table A-2, that have not been previously discussed in Table A-1, are given below:

Column Heading	Explanation
Site Number	State of Nevada Department of Highways pit or site number. Locations correspond to map numbers listed on this table and placed in Drawing 1.
Soundness Test	The testing of aggregates to determine their resistance to disintegration by saturated solutions of sodium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action particularly when adequate information is not available from service records of the material exposed to actual weathering conditions.

MAP NUMBER	SITE NUMBER	DATA SOURCE	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL				
							>6"	3"	1½"	1
64	WP10-1	Nevada Highway Department	Steptoe Valley	Aaf	Sandy Gravel	GP		97		
65	W-4	Nevada Highway Department	Steptoe Valley	Aaf	Sandy Gravel	GP			86.1	69

SIEVE ANALYSIS PERCENT PASSING												ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECI…		
															COARSE AGG…		
															SPECIFIC GRAV…		
1"	¾"	½"	¼"	⅜"	NO. 4	NO. 10	NO. 16	NO. 40	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	A…
	71			30													
69.9	61.4	51.8		47.1	37.8							20.8	5.2			2.51	

V

ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								PLASTICITY INDEX (ASTM D 423 AND D 424)	ALKALI REACTIVITY (ASTM C 289)	
			COARSE AGGREGATE				FINE AGGREGATE						
			SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT			CA	FA
20.8	5.2			2.51							NP		

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

Ertec
The Earth Technology Corporation

EXISTING TEST DATA
CAVE AND STEPTOE VALLEYS, NEVADA

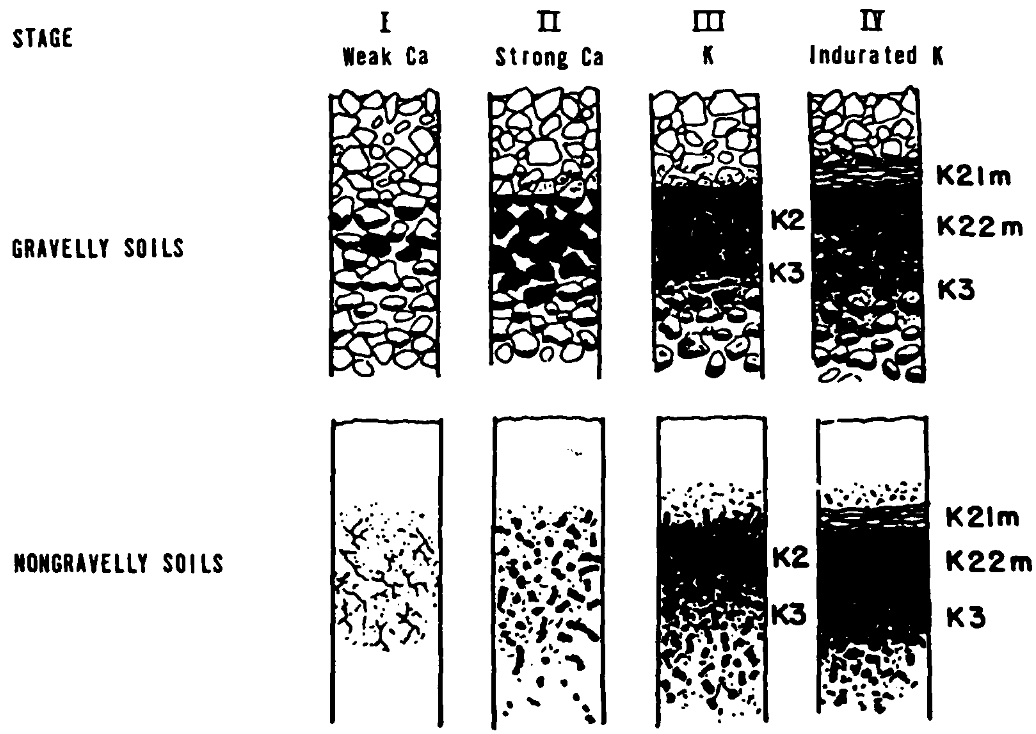
26 SEPT 81 PAGE 1 OF 1 TABLE A-2

APPENDIX B

SUMMARY OF CALICHE DEVELOPMENT

DIAGNOSTIC CARBONATE MORPHOLOGY

STAGE	GRAVELLY SOILS	NONGRAVELLY SOILS
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Laminar horizon overlying plugged horizon



Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

SUMMARY OF CALICHE DEVELOPMENT

APPENDIX C

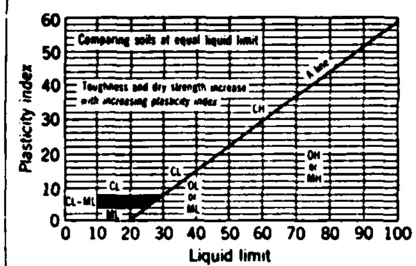
UNIFIED SOIL CLASSIFICATION SYSTEM

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)				Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils. More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels. More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics		Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures			Atterberg limits above "A" line, with *PI* greater than 7
	Sands. More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand, gravelly*; about 20% hard, *angular gravel particles* ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines			Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures			Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures			Atterberg limits below "A" line with *PI* greater than 7

Identification Procedures on Fraction Smaller than No. 40 Sieve Size

		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils. More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, *amount and maximum size of coarse grains*; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	

Use grain size curve in identifying the fractions as given under field identification



Plasticity chart for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW–GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):
After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.
Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):
After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):
After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.
Highly organic clays have a very weak and spongy feel at the plastic limit.

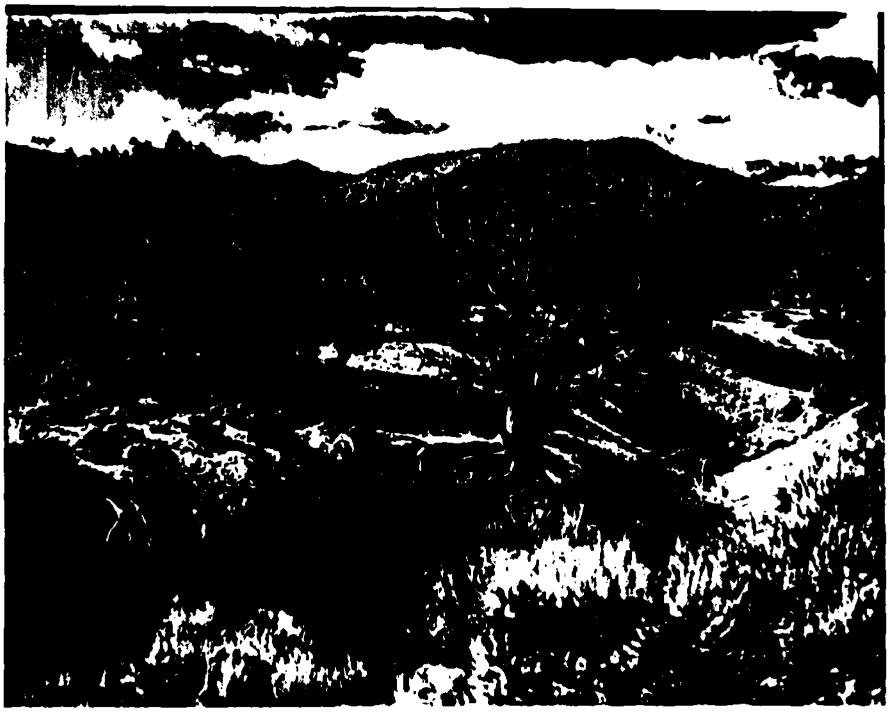
Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

UNIFIED SOIL CLASSIFICATION SYSTEM

APPENDIX D

CAVE AND STEPTOE VALLEYS, STUDY AREA PHOTOGRAPHS



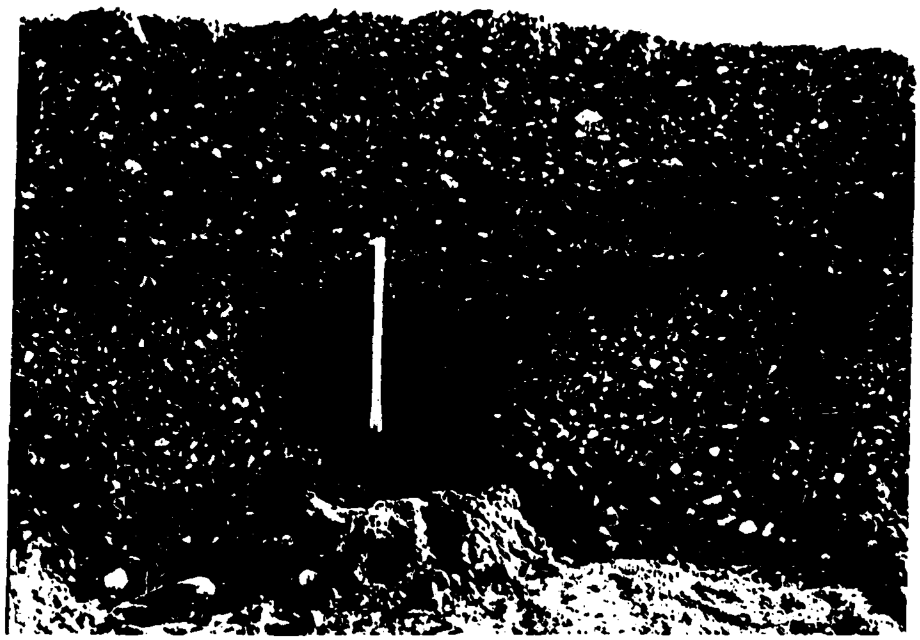
Alluvial Fan Deposit (Aafs) in southwestern Cave Valley; Class I coarse/Class II fine aggregate source (Station 17).

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

CAVE AND STEPTOE VALLEYS
STUDY AREA PHOTOGRAPH

FIGURE D-1



Undifferentiated Alluvial Deposit (Au) in northern Steptoe Valley; Class II coarse/Class I fine aggregate source (Station 33).

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

CAVE AND STEPTOE VALLEYS
STUDY AREA PHOTOGRAPH

FIGURE D-2

Simonson Dolomite (Do) in southern Schell Creek Range; Class I crushed rock aggregate source (Station 3).

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

CAVE AND STEPTOE VALLEYS
STUDY AREA PHOTOGRAPH

FIGURE D-3

Arcturus Formation (Su) in central Egan Range; depicted limestone bed is a Class I crushed rock aggregate source (Station 43).

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

CAVE AND STEPTOE VALLEYS
STUDY AREA PHOTOGRAPH

FIGURE D-4

APPENDIX E

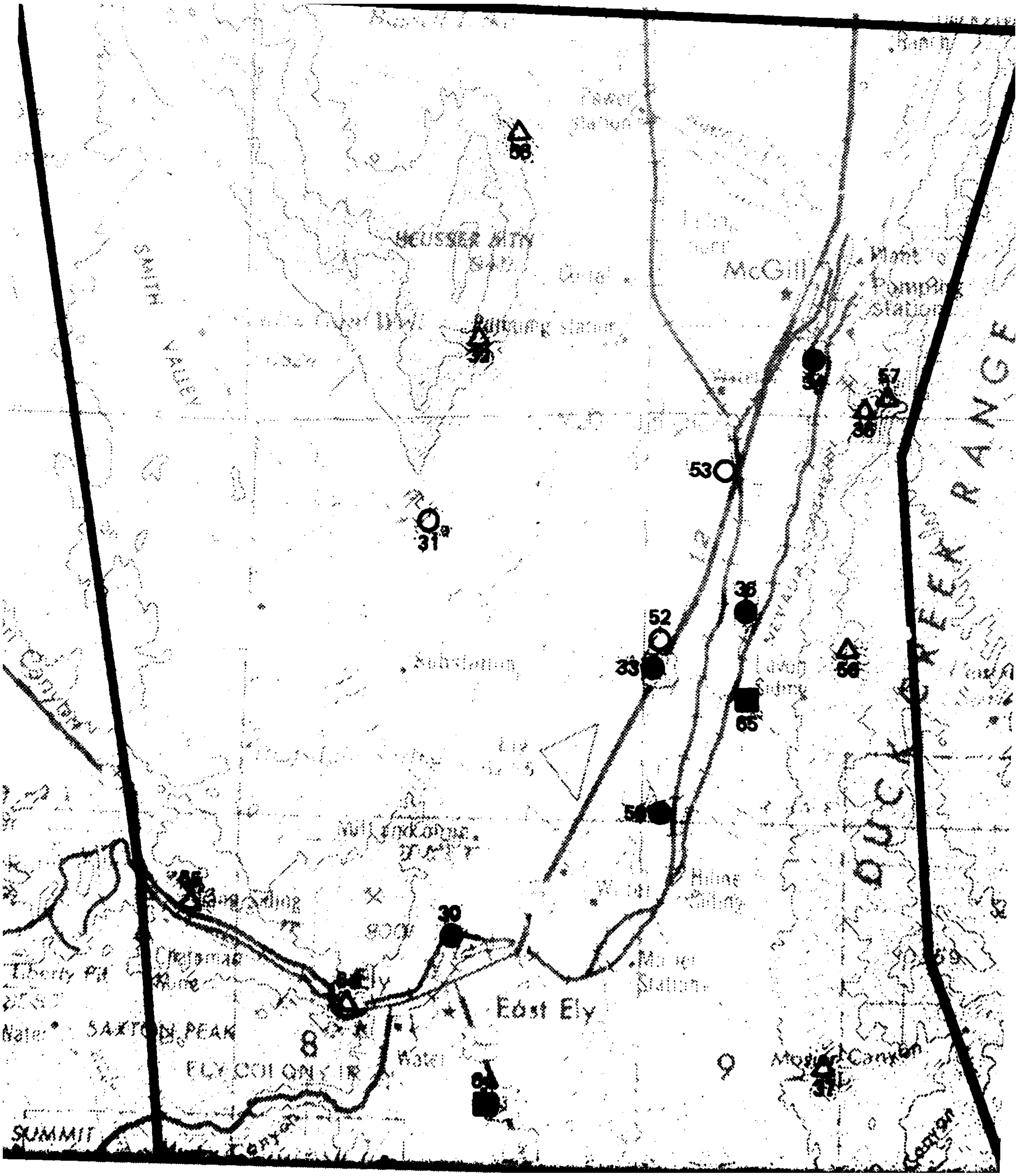
ERTEC WESTERN, INC., GEOLOGIC UNIT CROSS REFERENCE

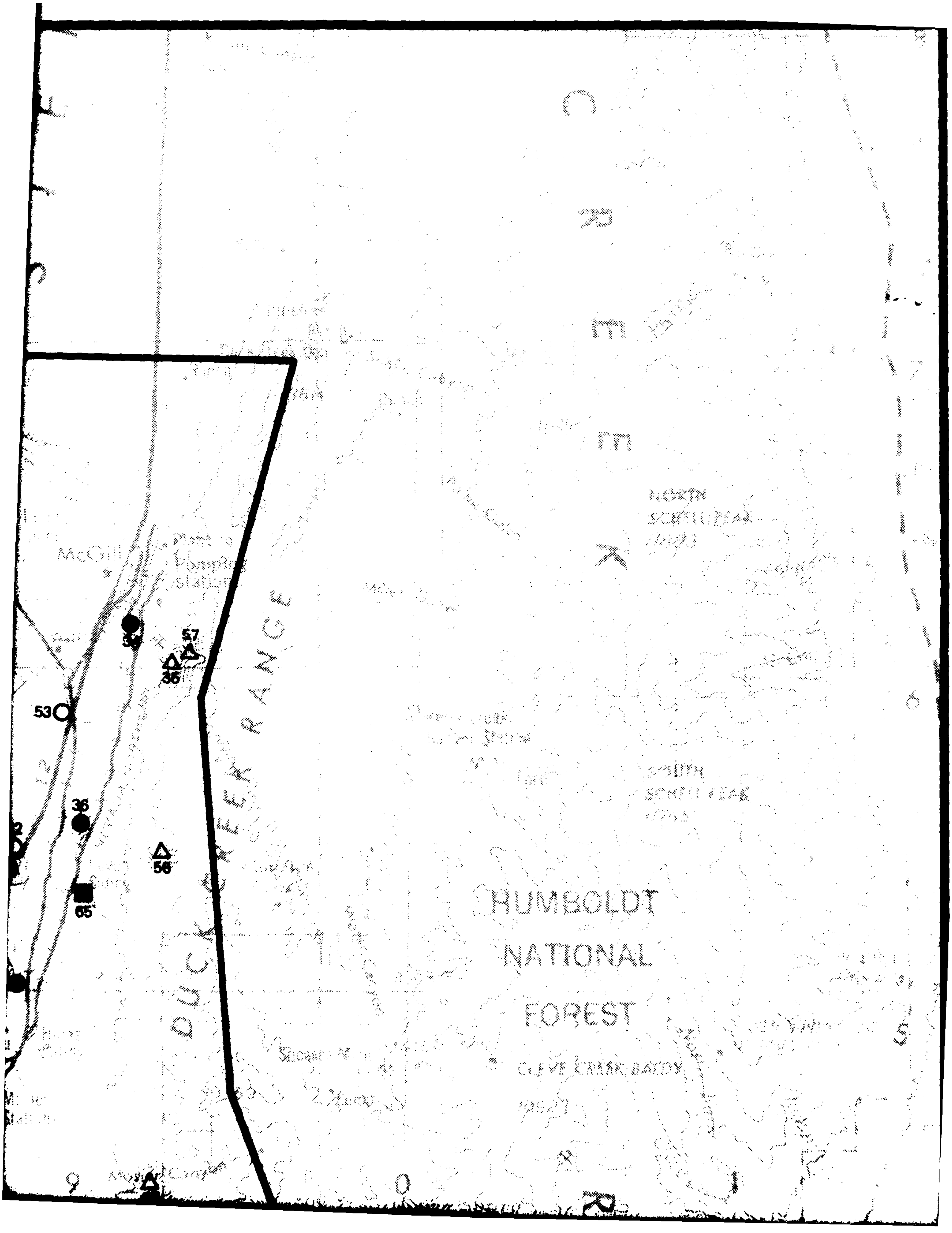
AGGREGATE RESOURCES GEOLOGIC UNIT SYMBOLS	ERTEC WESTERN GENERAL GEOLOGIC UNIT EXPLANATION	
		ROCK
		Shown in regions where rock is exposed, the areally predominant (greater than 70 percent) rock type is indicated. In those areas where two rock types occur the predominant rock type is shown followed by the subordinate rock type (e.g. S_{2a}/I_4). Rock may be subdivided into bedrock (R).
	I	IGNEOUS (UNDIFFERENTIATED): Rocks formed by solidification of a molten or partially molten mass.
Gr	I_1	Intrusive: Plutonic rocks formed by solidification of molten material beneath the surface (e.g. granite, granodiorite, diorite, gabbro).
Vu	I_2	Extrusive (intermediate and acidic): Volcanic rocks of intermediate and acidic composition formed by solidification of molten material at or near the surface (e.g. rhyolite, latite, dacite, andesite).
Vb	I_3	Extrusive (basic): Volcanic rocks of basic composition generally formed by solidification of molten materials at or near the surface (e.g. basalt).
Vu	I_4	Extrusive (pyroclastic): Rocks formed by accumulation of volcanic ejecta (e.g. ash, tuff, welded tuff, agglomerate).
Su	S	SEDIMENTARY (UNDIFFERENTIATED): Rocks formed by accumulation of clastic solids, organic solids and/or chemically precipitated minerals.
Su, Qtz	S_1	Arenaceous and/or Siliceous Rocks: Composed of sand size particles (e.g. sandstone, orthoquartzite) or of cryptocrystalline silica (e.g. opal, chert).
Ls, Do, Cau	S_2	Carbonate Rocks: Composed predominantly of calcium carbonate detritus or chemical precipitates (e.g. limestone, dolomite, chalk).
	S_3	Argillaceous Rocks: Composed of clay and silt-sized particles (e.g. siltstone, shale, claystone).
	S_4	Evaporite Rocks: Precipitated from solution as a result of evaporation (e.g. halite, gypsum, anhydrite, sylvite).
Su	S_5	Coarse Clastic Rocks: Composed of gravel-sized or larger clasts (e.g. conglomerate, breccia).
Mu	M	METAMORPHIC (UNDIFFERENTIATED): Rocks formed through recrystallization in the solid state of preexisting rocks by heat and pressure.
Mu	M_1	Coarse grained: rocks formed by higher-grade regional metamorphism, either banded or granular (e.g. gneiss, granulite, amphibolite).
Mu	M_2	Fine grained: schistose rocks formed by lower grade regional metamorphism (e.g. schist, slate, phyllite).
Mu	M_3	Nonfoliated: rocks formed chiefly by contact metamorphism (e.g. hornfels, marble).
Qtz	M_4	Metaquartzite: rocks formed by metamorphism of highly siliceous rocks.
		BASIN-FILL
	A	BASIN-FILL DEPOSITS: Fine- to coarse-grained materials deposited principally by wind, water or gravity.
Aal	A_1	Younger Fluvial Deposits: Major modern stream channel and flood-plain deposits.
Au, Aal	A_2	Older Fluvial Deposits: Older incised stream channel and flood-plain deposits in elevated terraces bordering major modern drainages.
Au	A_3	Eolian Deposits: Wind-blown deposits of sand occurring as either thin sheets (A_{3s}) or dunes (A_{3d}).
Aol	A_4	Playa and Lacustrine Deposits: Deposits occurring in modern, active playas (A_4) or in either inactive playas or older lake beds and abandoned shorelines associated with extinct lakes (A_{4o}).
Aaf	A_5	Alluvial Fan Deposits: Alluvial deposits consisting of debris flow and water laid alluvium near mountain fronts, grading into predominantly water laid alluvium deposited in shifting distributary channels near the basin center. Younger (A_{5y}), intermediate (A_{5i}) and older (A_{5o}) alluvial fans are differentiated by surface soil development, terrain conditions and present depositional/erosional environment.
Au	A_3/A_5	Mixed non-rock units: Most areally extensive unit is listed first.
Aaf	A_{5y} (A_{5i})	Parenthetic unit underlies thin veneer of overlying mapped unit.

Ertec The Earth Technology Corporation

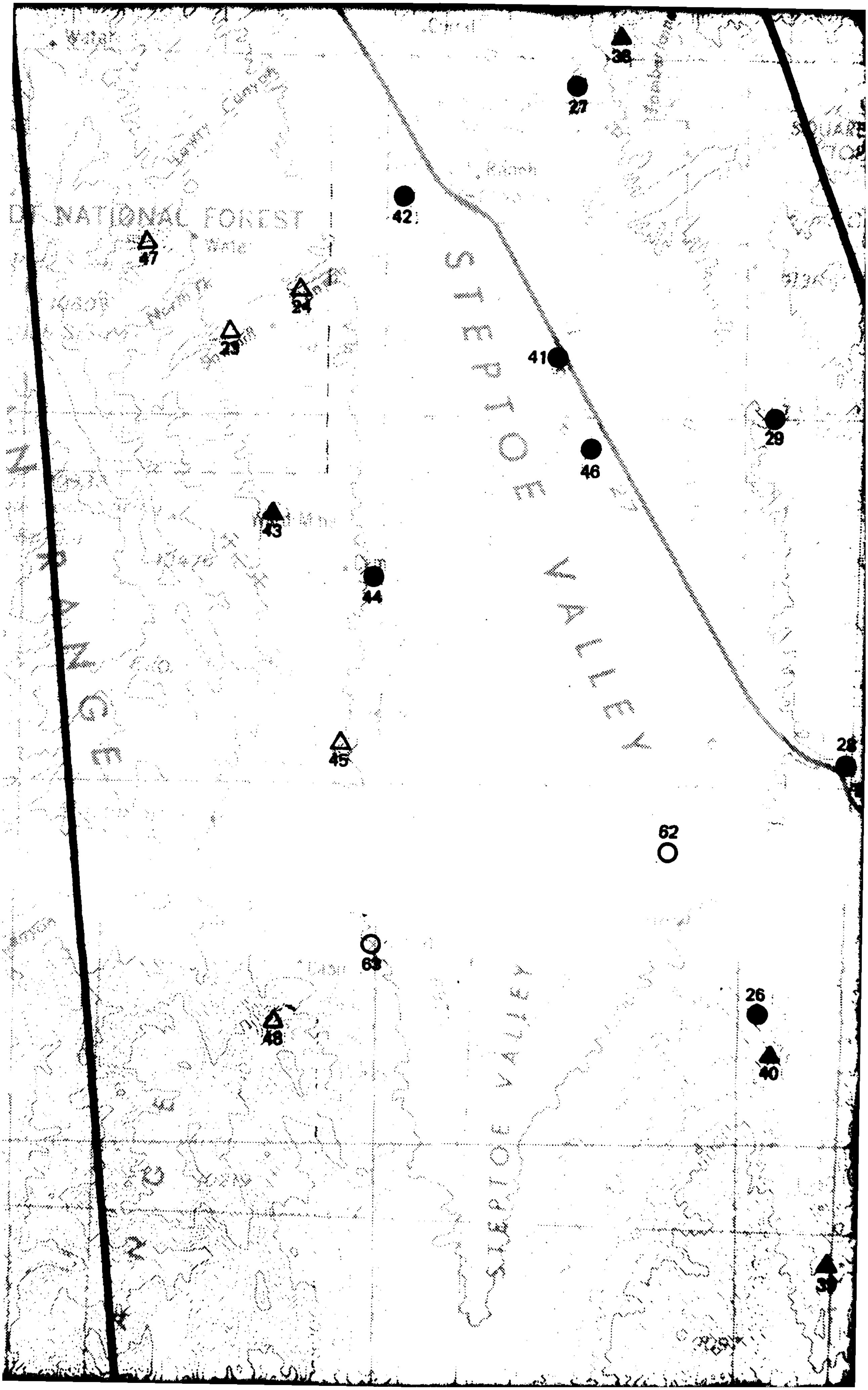
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

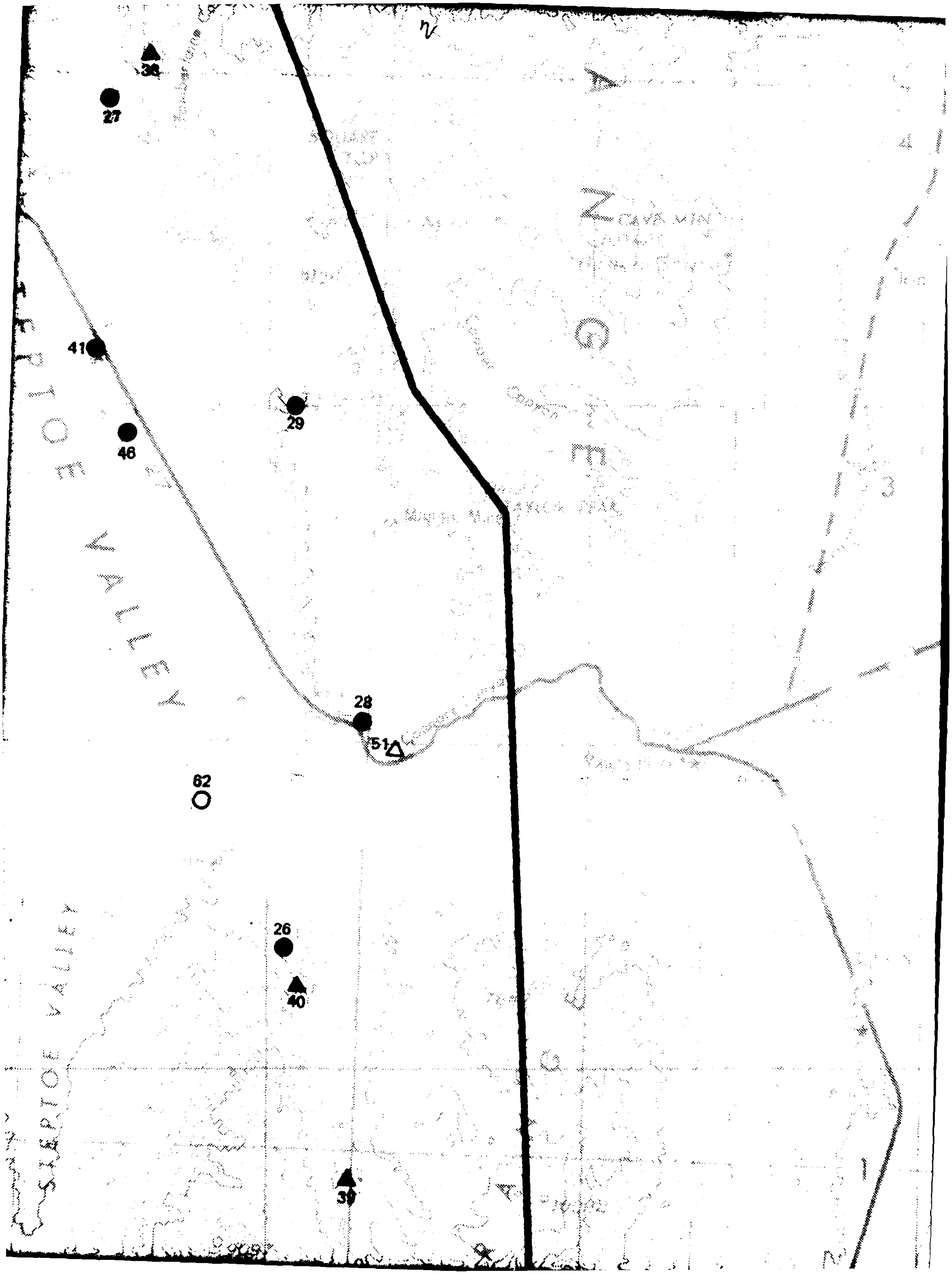
ERTEC WESTERN GEOLOGIC UNIT CROSS REFERENCE

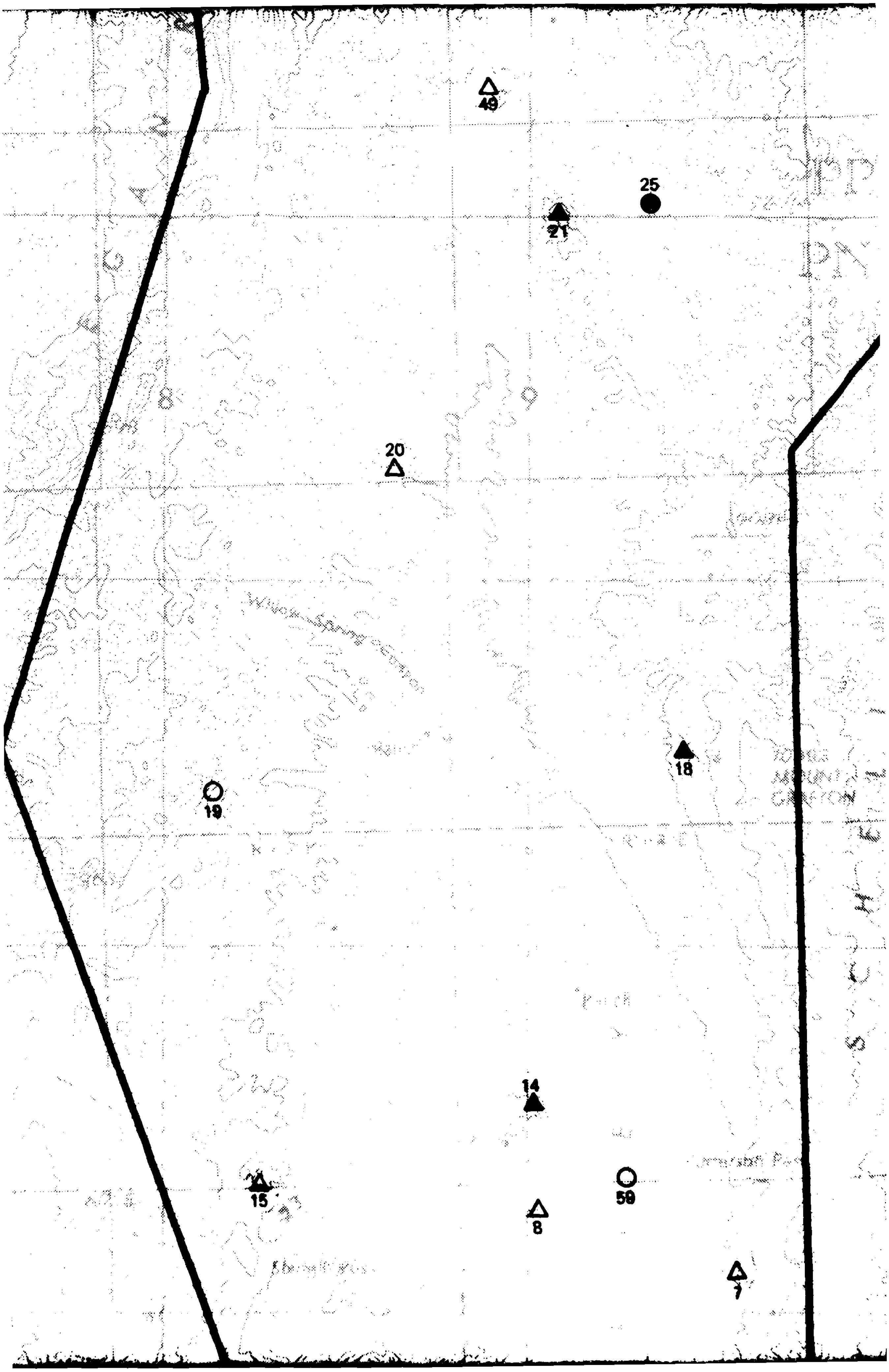

McGill
East Ely
Ely
DUCK CREEK RANGE
SMITH VALLEY
SAXTON PEAK
ELY COLONY IR
SUMMIT
Mogul Canyon
Liberty Pit
8
9
53
52
33
31
30
35
36
56
57
58
65
37



McGill
53
57
35
36
56
65
DUCK CREEK RANGE
NORTH
SCHELL PEAK
SOUTH
SCHELL PEAK
HUMBOLDT
NATIONAL
FOREST


NATIONAL FOREST
STEPTOE VALLEY
STEPTOE VALLEY
RANGE
38
27
42
47
24
23
41
29
46
43
44
45
28
62
63
26
40
48


38
27
CAVE MTN
41
29
46
3
4
28
51
62
26
40
39
STEPTOE VALLEY


49
25
21
20
18
19
14
15
8
7

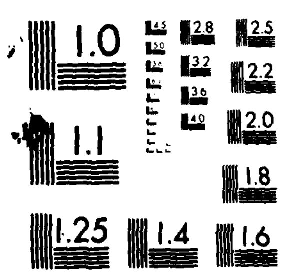
AD-A113 068 ERTEC WESTERN INC LONG BEACH CA F/G 8/7
AGGREGATE RESOURCES STUDY, CAVE AND STEPTOE VALLEYS, NEVADA.(U)
SEP 81 F04704-80-C-0006
UNCLASSIFIED E-TR-37-J NL

2 - 2

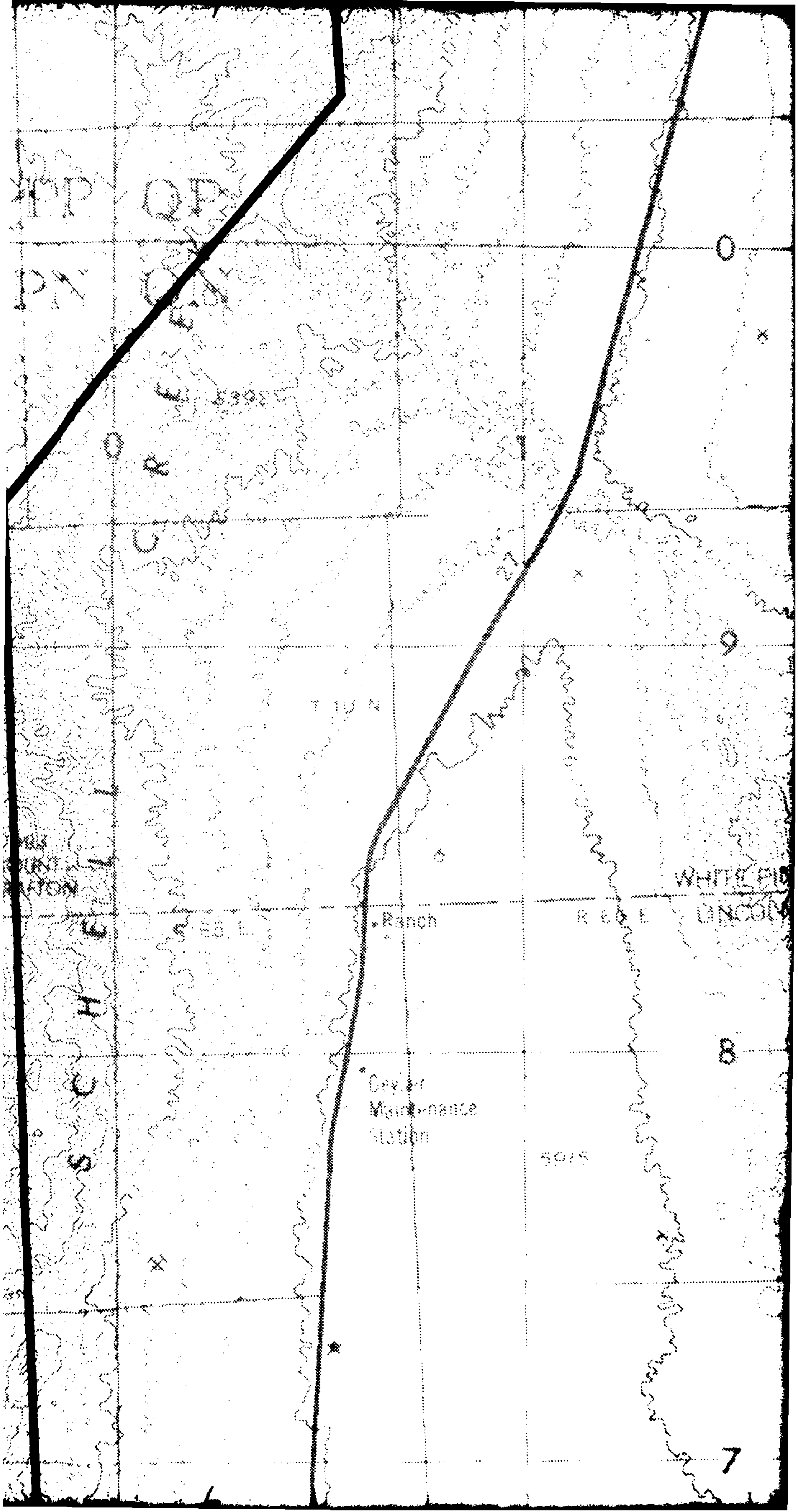
END
DATE
FILMED
4 82
DTIC

2 OF 2

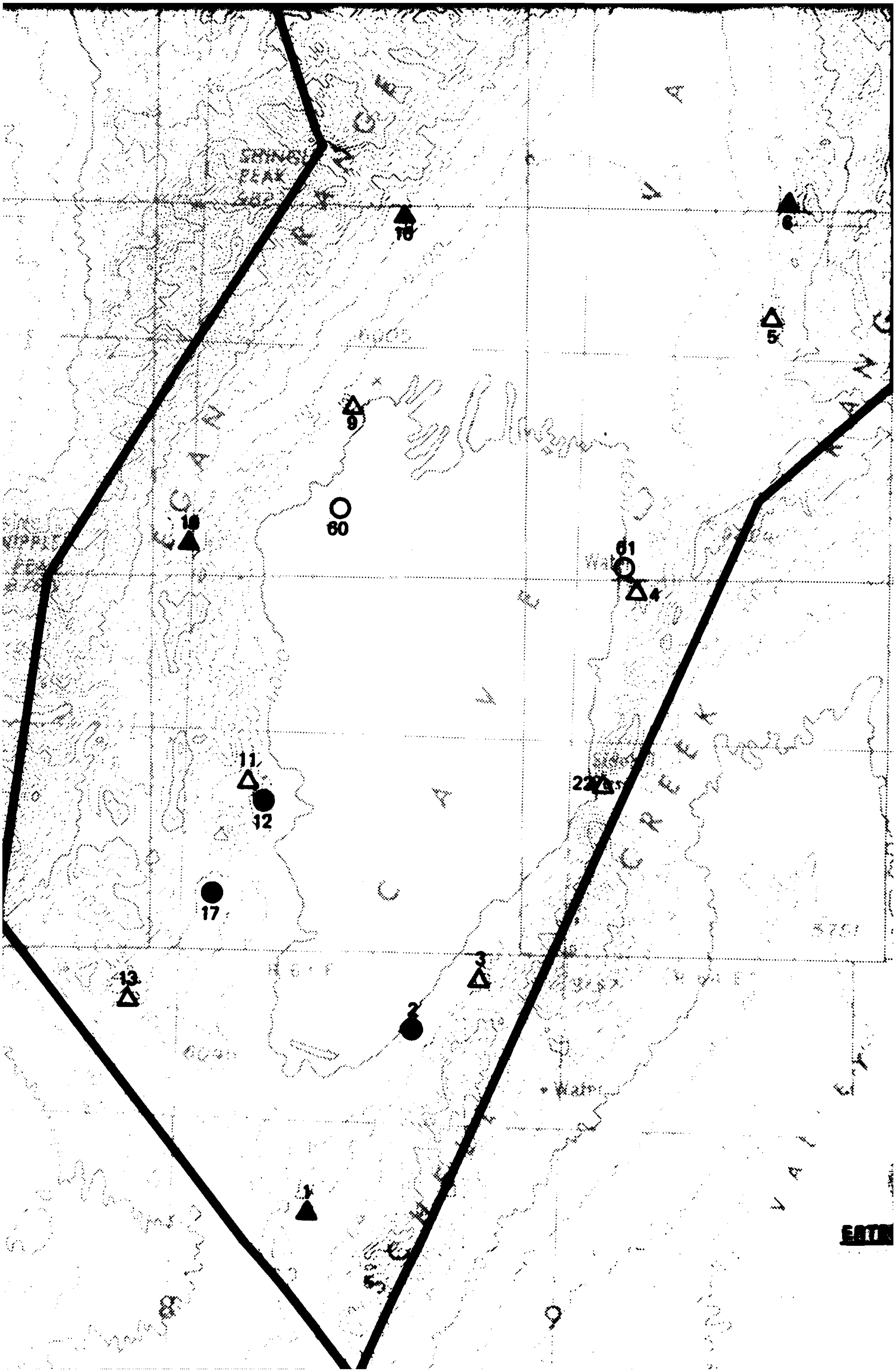
AD-
A113068

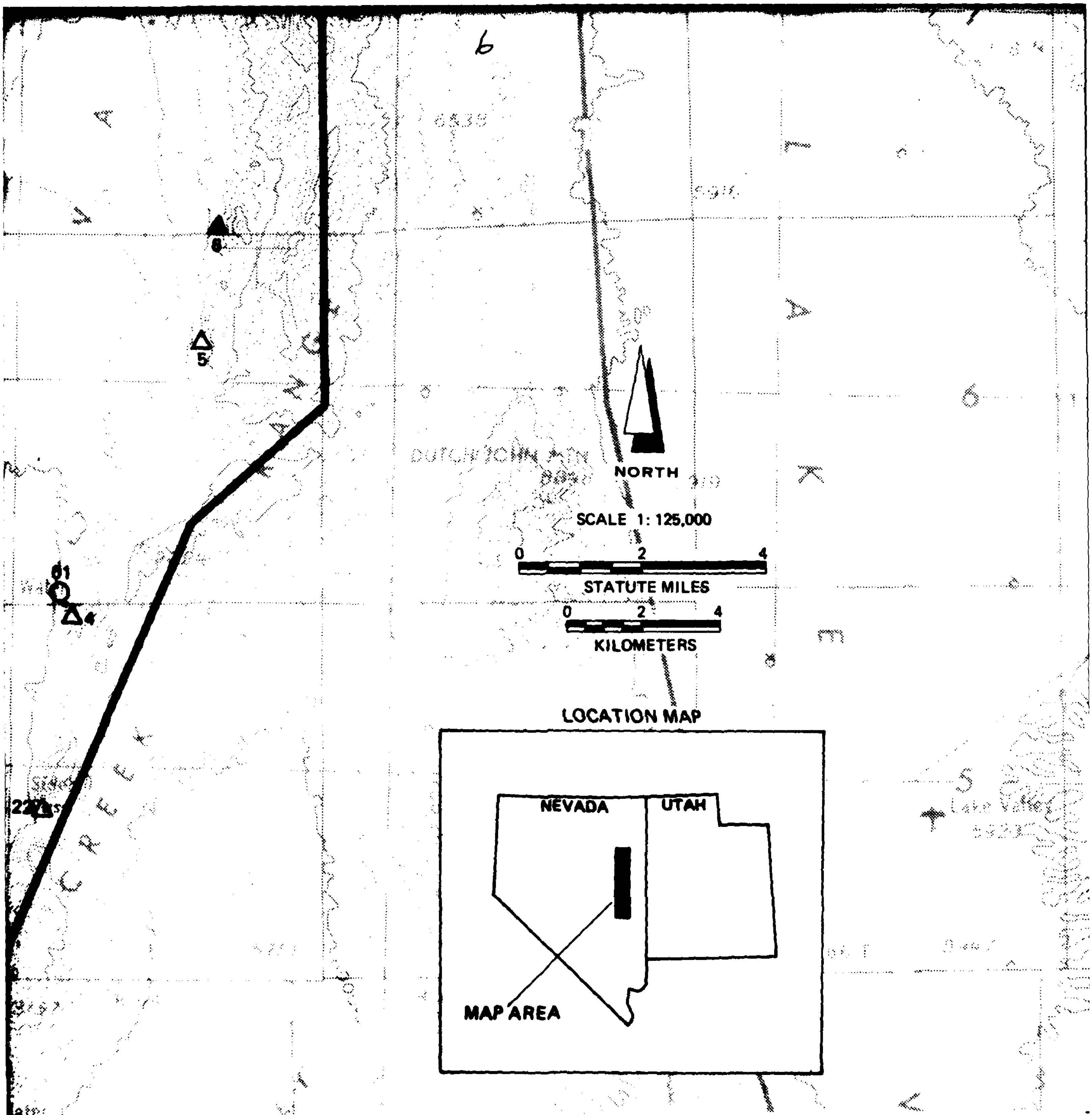


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A



PP
QP
PN
QN
0
9
8
7
T 10 N
Ranch
Station


10
6
5
9
60
18
61
4
11
12
22
17
13
3
2
1

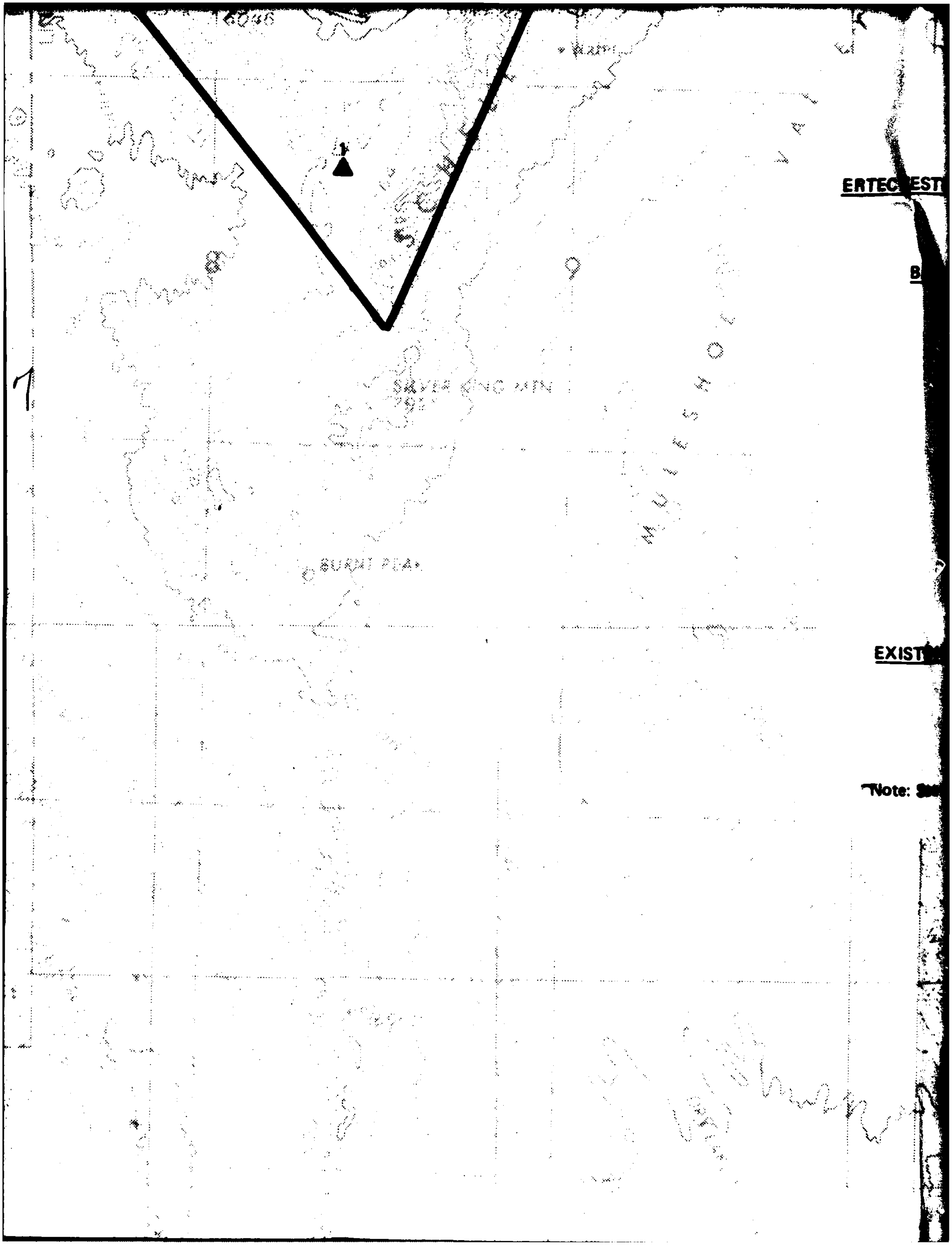


EXPLANATION

ERTEC WESTERN FIELD STATIONS

BASIN–FILL UNITS (Potential Coarse and/or Fine Aggregates)

● Data Stop, Sampled and Tested



SILVER KING MTN
BURNT PEAK
MULESHOE
8
9
7
ERTEC
EXIST
Note:

EXPLANATION

ERTEC WESTERN FIELD STATIONS

BASIN–FILL UNITS (Potential Coarse and/or Fine Aggregates)

● Data Stop, Sampled and Tested

8

○ Data Stop

ROCK UNITS (Potential Crushed Rock Aggregates)

▲ Data Stop, Sampled and Tested

△ Data Stop

EXISTING TEST DATA SITES

■ Test Data Available*

*Note: See Corresponding Map Number in Appendix A for Detailed Information

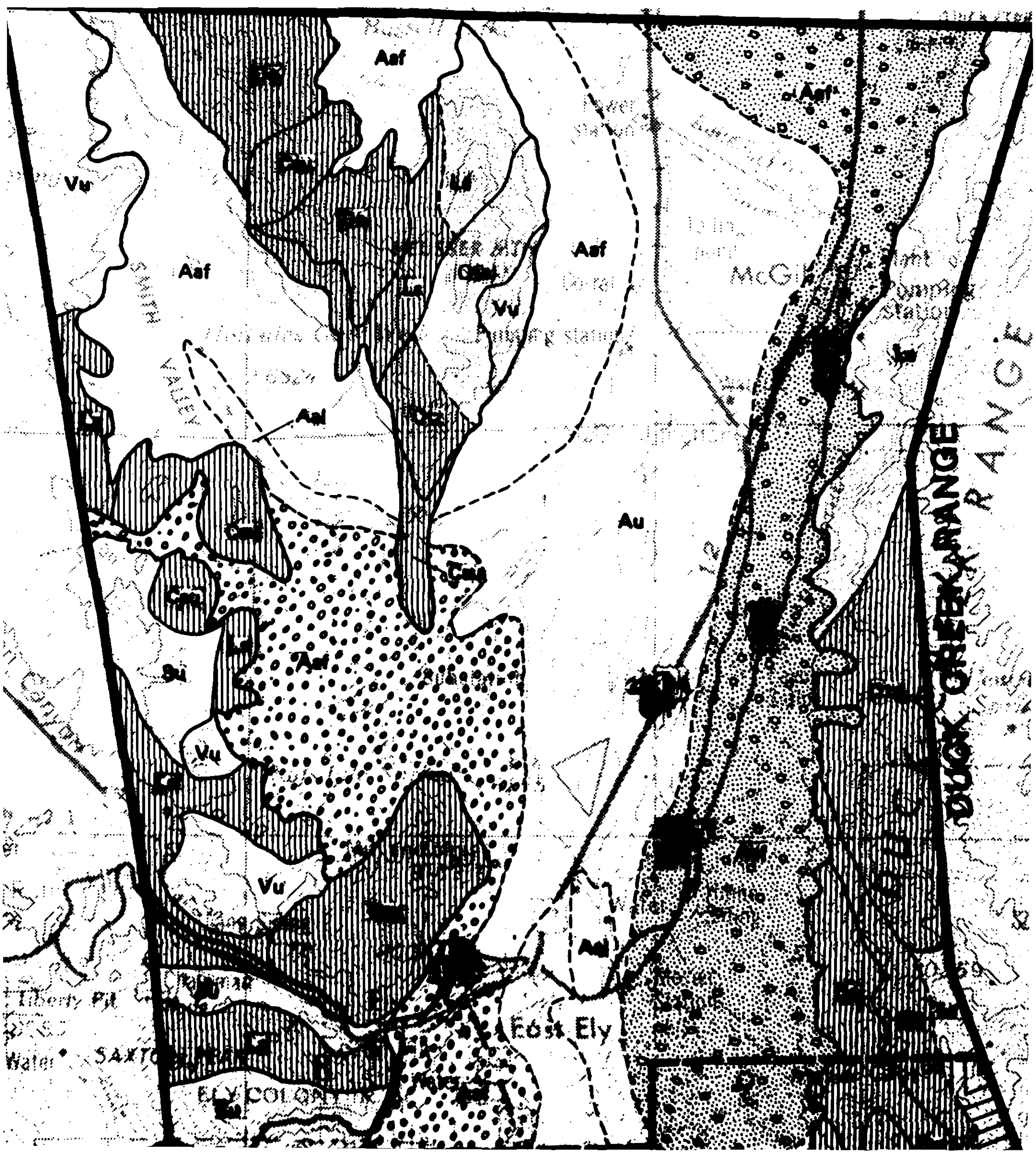
Ertec
The Earth Technology Corporation

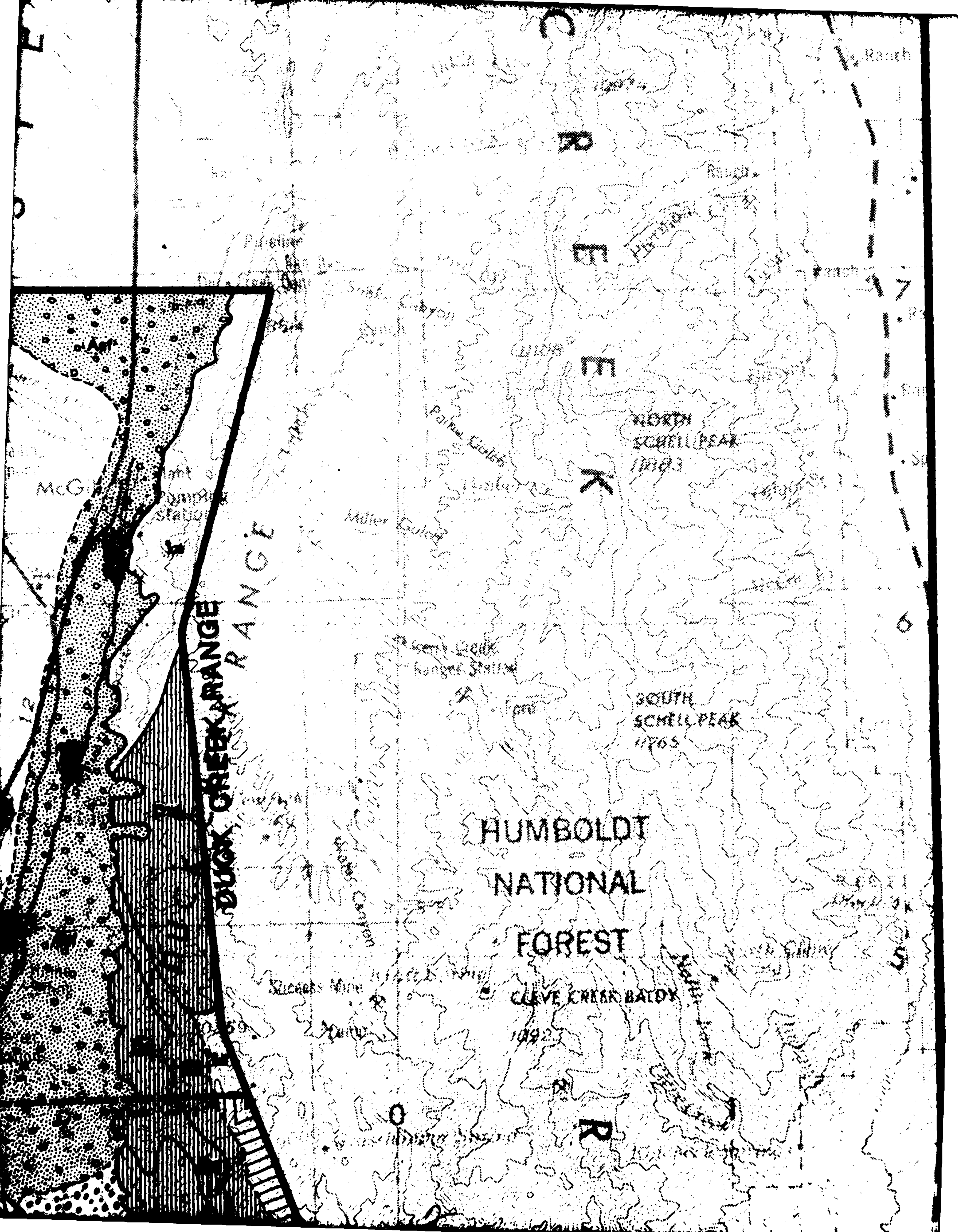
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

ERTEC WESTERN FIELD STATION
AND EXISTING DATA SITE LOCATIONS
CAVE AND STEPTOE VALLEYS, NEVADA

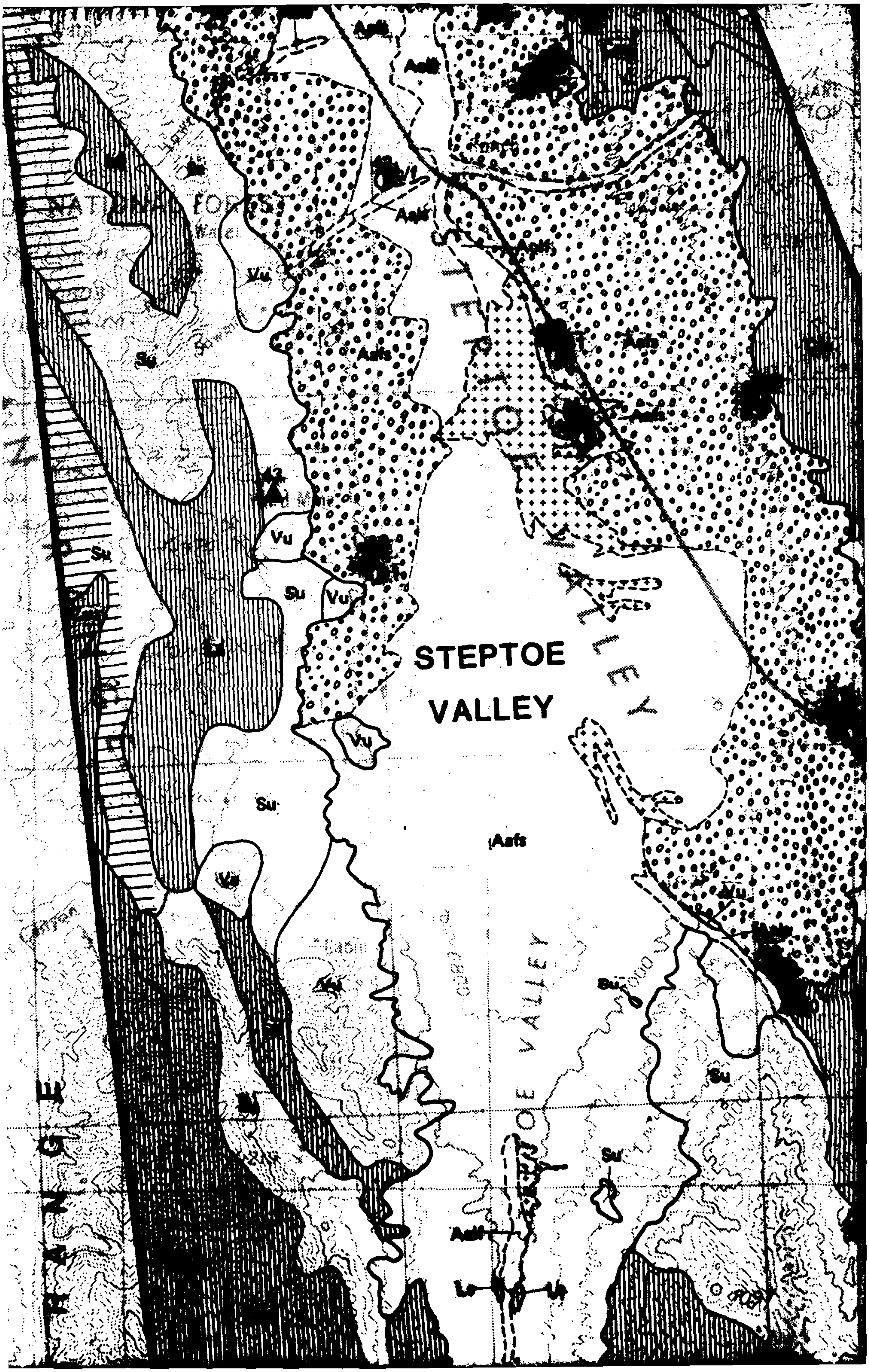
25 SEPT 81

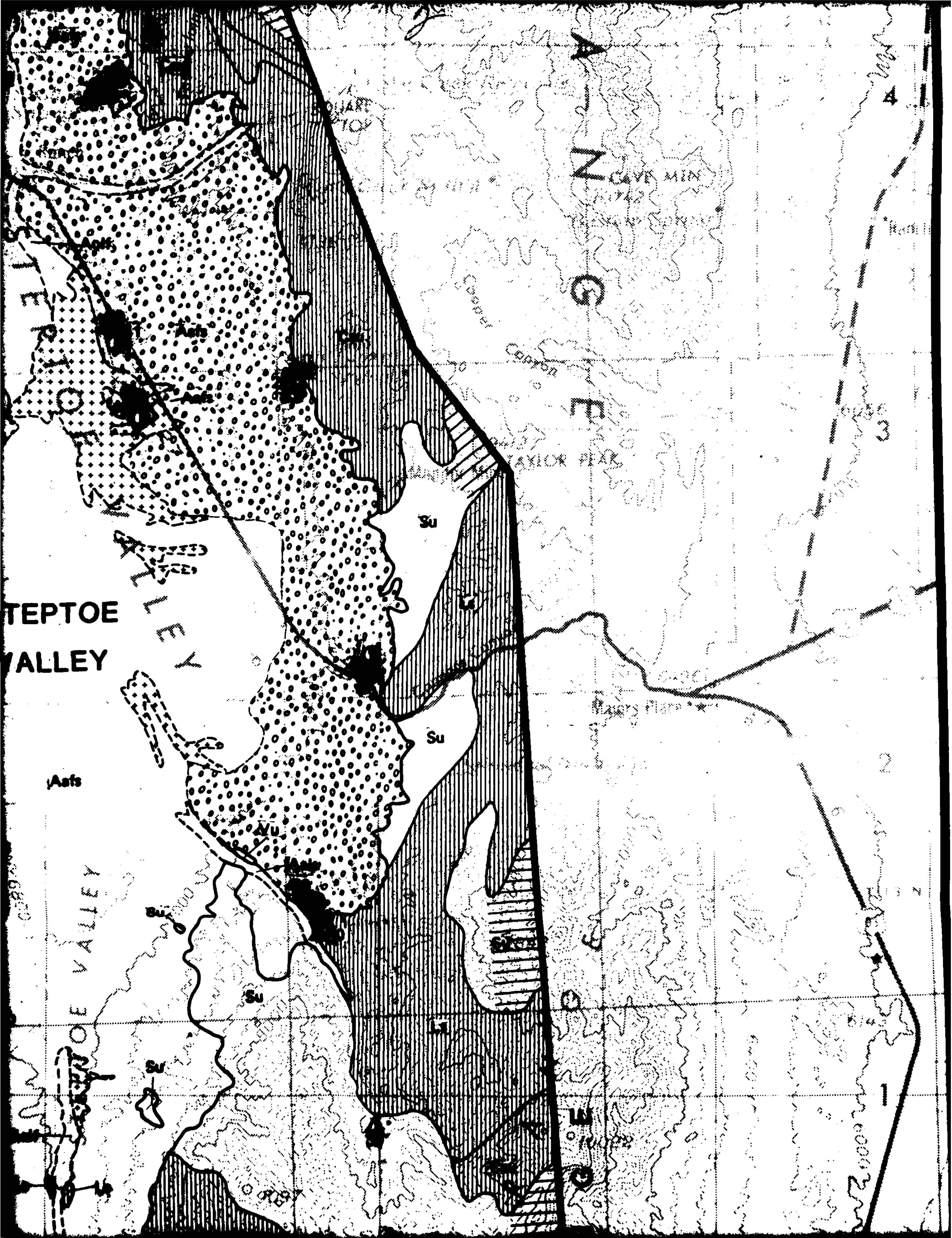
DRAWING 1


Aaf
Vu
Aaf
Aal
Au
McGill
DUCK CREEK RANGE
RANGE
SMITH VALLEY
East Ely
ELY COLONY
Liberty Pit
SAXTON

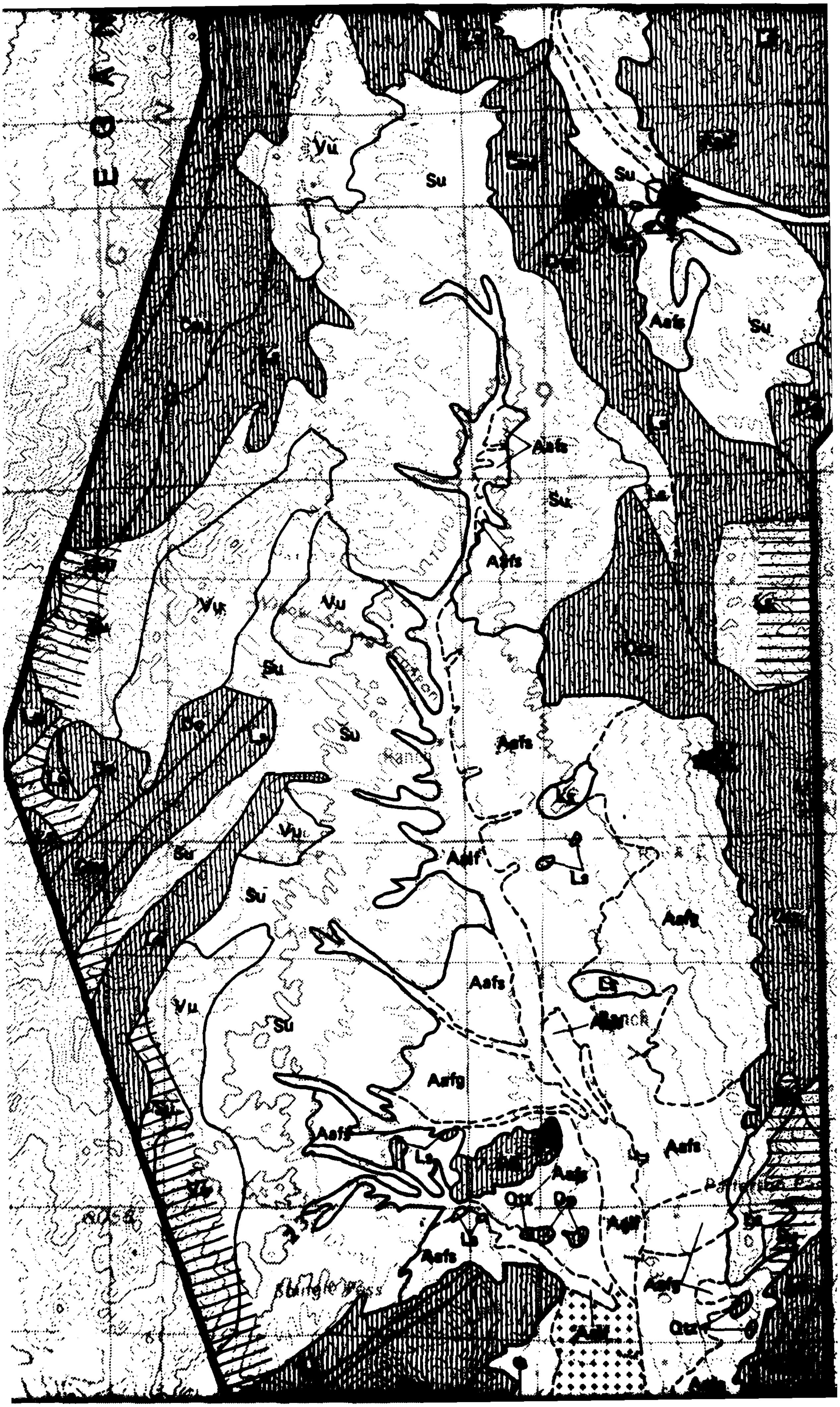


C
R
E
E
K
Pipeline
NORTH
SCHELL PEAK
11883
Miller Gulch
RANGE
DUCK CREEK RANGE
Schell Creek
Ranger Station
SOUTH
SCHELL PEAK
11765
HUMBOLDT
NATIONAL
FOREST
CLEVE CREEK BALDY
11092
R
7
6
5
0

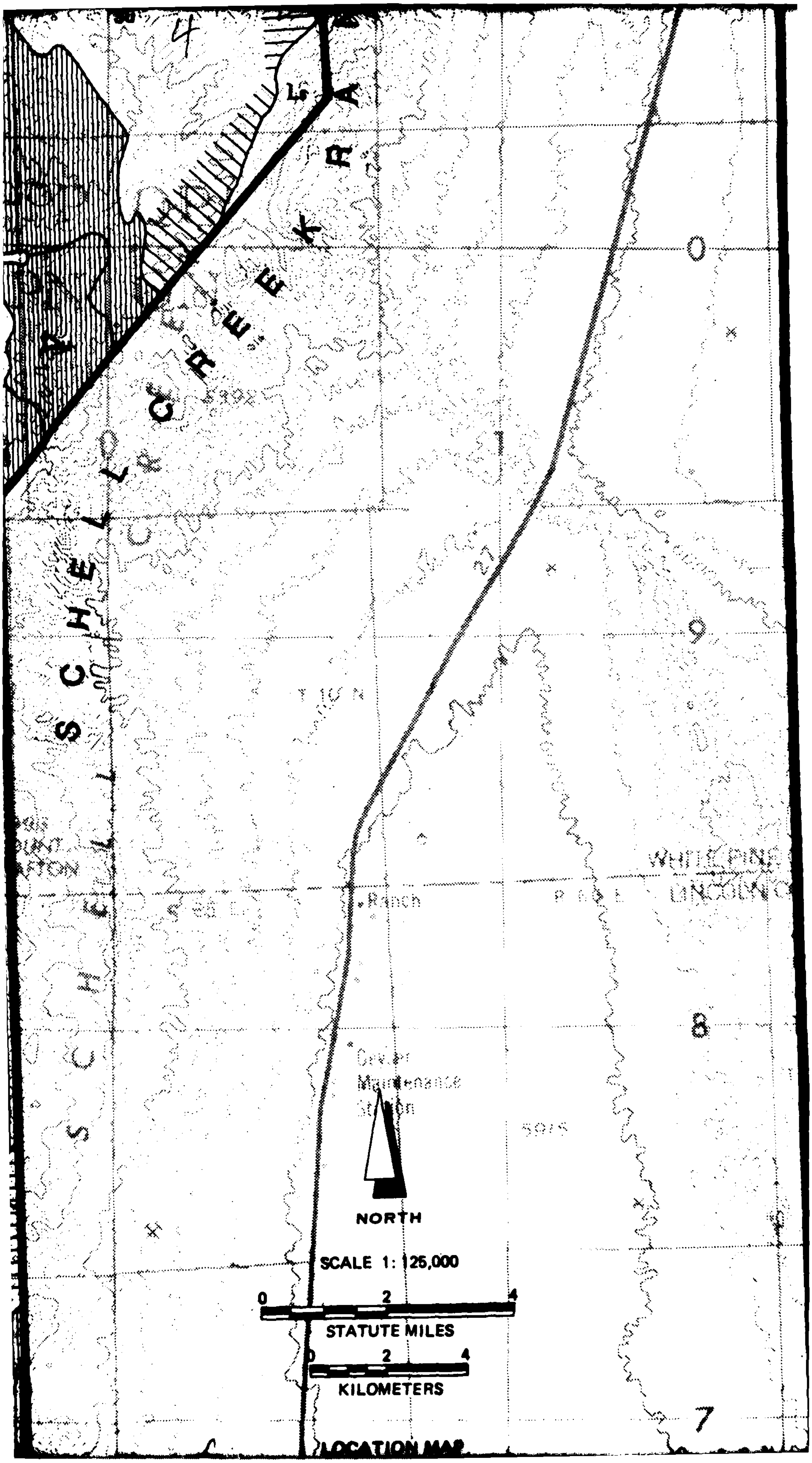

STEPTOE
VALLEY
Aafs
Aaf
Su
Vu
Lc



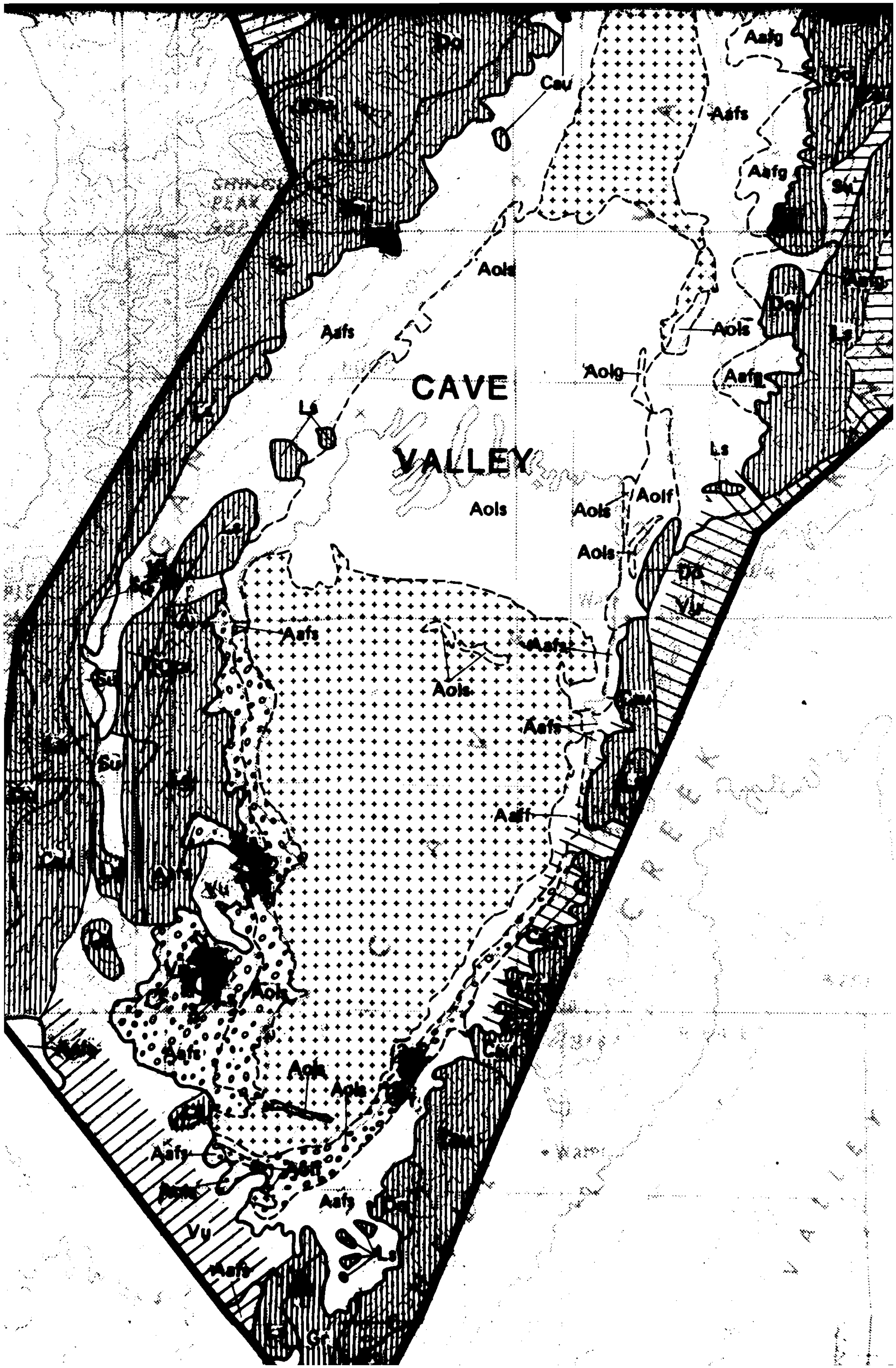
STEPTOE VALLEY
STEPTOE VALLEY
STEPTOE VALLEY
CAVE MTN
TAYLOR PEAK
Su
Su
Su
Su
Aafs
Aafs
Aafs
4
3
2
1



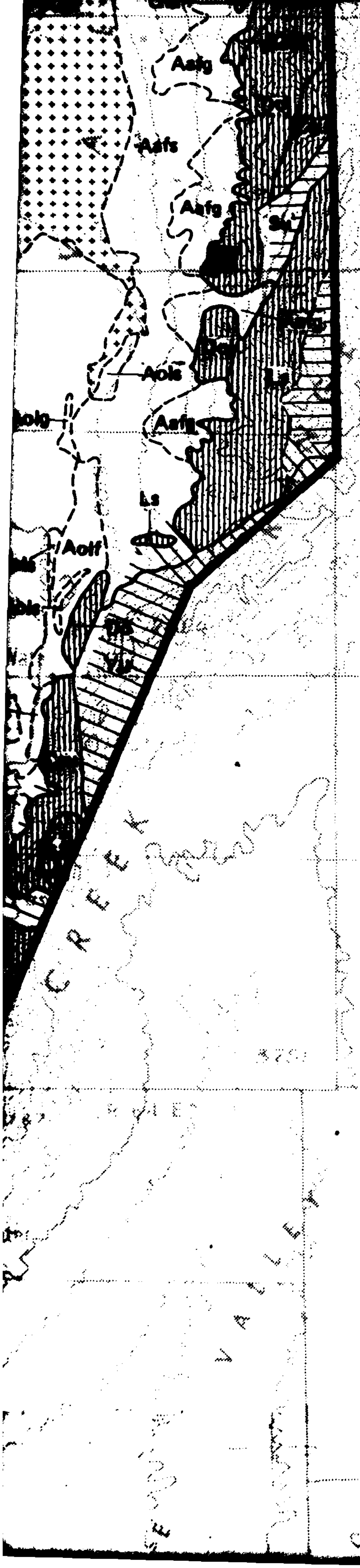
Vu
Su
Aafs
Vu
Su
Aafs
Vu
Su
Aafs
Ls
Vu
Su
Aafs
Aafg
Ls
Qtr
Dp
Shingle Pass

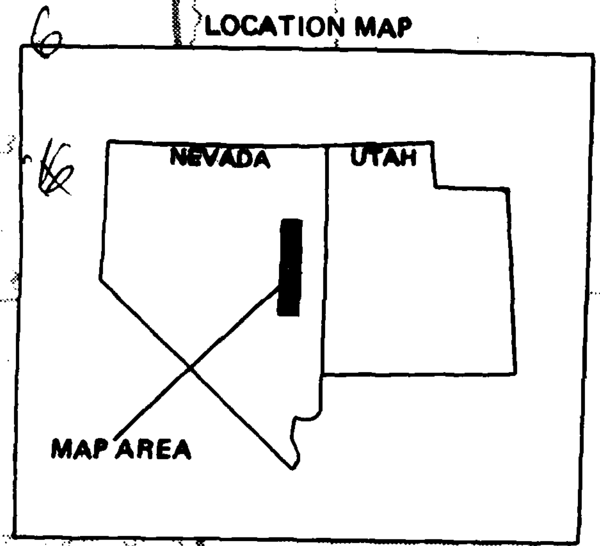


SCHELL CREEK RANGE
Ranch
WHITE PINE
LINCOLN
NORTH
SCALE 1: 125,000
0 2 4
STATUTE MILES
0 2 4
KILOMETERS
LOCATION MAP



CAVE
VALLEY
Aols
Aafs
Aafg
Aolg
Aolf
Aaff
Cau
Ls
Do
Su
Vu





EXPLANATION

POTENTIAL AGGREGATE SOURCES

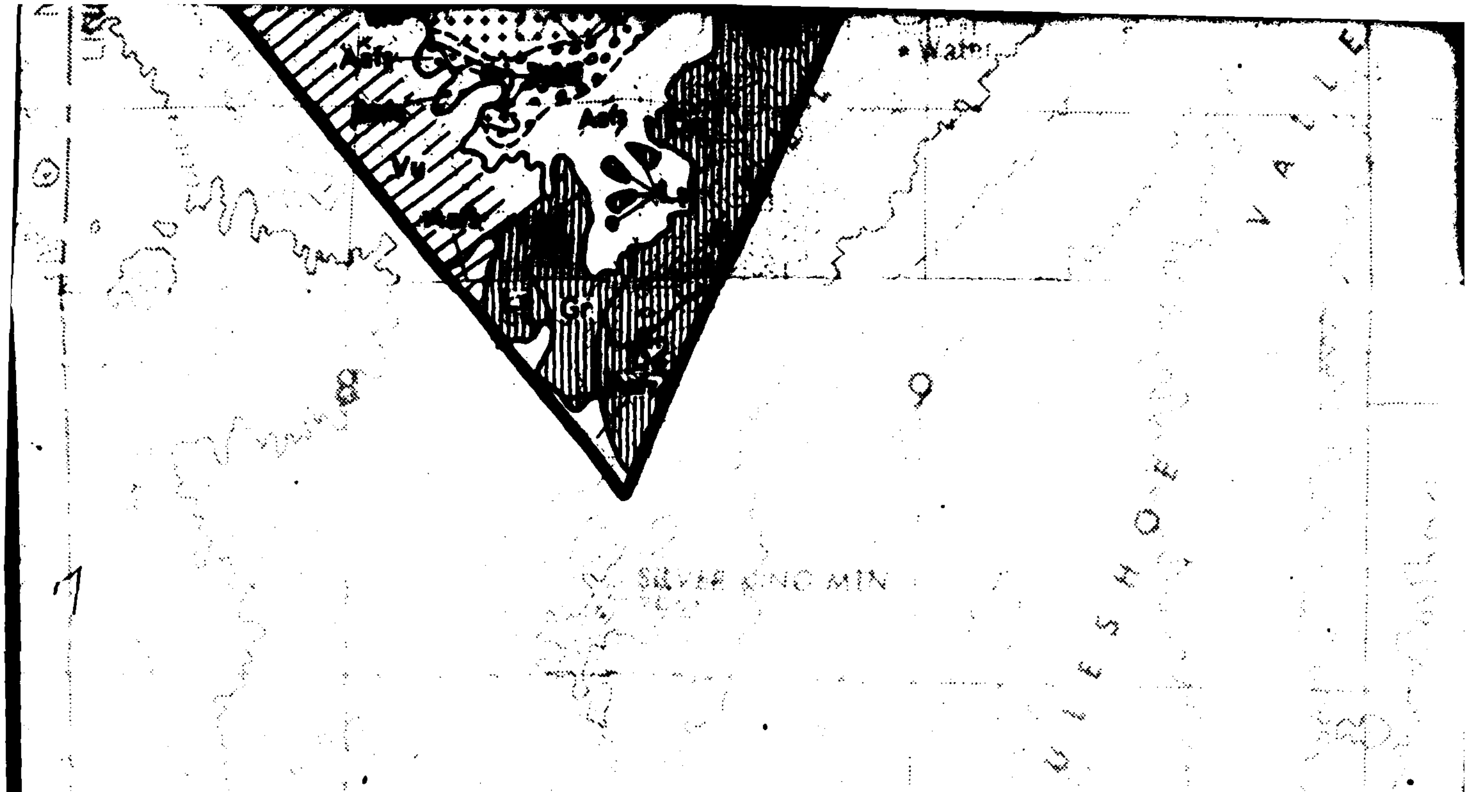
BASIN–FILL UNITS *

Aal	Stream Channel and Terrace Deposits	(A1)
Aaf	Alluvial Fan Deposits	(A5)
Aol	Older Lacustrine Deposits	(A4o)
Au	Alluvial Deposits Undifferentiated	

ROCK UNITS*

Vu	Volcanic Rocks Undifferentiated	(I2 and/or I4)
Gr	Granite Rock	(I1)
Qtz	Quartzite	(M4 and/or S1)
Ls	Limestone	(S2)
Do	Dolomite	(S2)
Cau	Carbonate Rocks Undifferentiated	(S2)
Su	Sedimentary Rocks Undifferentiated	(S)

* Reference Appendix E for Symbol Explanation and Composition



BASIN–FILL SOURCES

Class I – Potentially Suitable Coarse
Concrete Aggregate or Road - Base Material Source

Class I – Potentially Suitable Coarse and Fine (Multiple Type Source)
Concrete Aggregate or Road - Base Material Source

ROCK SOURCES

Class I – Potentially Suitable Crushed Rock
Concrete Aggregate or Road - Base Material Source

BASIN–FILL AND ROCK SOURCES

Class II – Possibly Unsuitable Coarse, Fine and/or Crushed Rock Concrete
Aggregate/Potentially Suitable Road-Base Material Source

Class III – Unsuitable Coarse, Fine and/or Crushed Rock Concrete
Aggregate or Road-Base Material Source

Qtz	Quartzite	(M4 and/or S1)
Ls	Limestone	(S2)
Do	Dolomite	(S2)
Cau	Carbonate Rocks Undifferentiated	(S2)
Su	Sedimentary Rocks Undifferentiated	(S)

• Reference Appendix E for Symbol Explanation and Comparison

Aafg — Material type (Aaf) and Grain Size Designation (g). Grain size designations are gravel (g), sand (s), and silt and/or clay (f).

– – – Geologic Contact, Dashed Where Approximate

– – – – Approximate Concrete Aggregate and/or Road-Base Materials Source Boundary

Verification Study Area

SAMPLED AND TESTED FIELD STATIONS

BASIN-FILL AGGREGATE SAMPLE COARSE (c) AND FINE (f)	CRUSHED ROCK SAMPLE	CLASSIFICATION
●	▲	CLASS I
◐	▲	CLASS II
○	△	CLASS III

NOTE: SEE CORRESPONDING MAP NUMBER IN APPENDIX A FOR DETAILED INFORMATION

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

AGGREGATE RESOURCES MAP
CAVE AND STEPTOE VALLEYS, NEVADA

25 SEPT 81 — DRAWING 2

Source

ple Type Source)

Source

Source

shed Rock Concrete

ntial Source

k Concrete